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Dr. Swapnesh Taterh

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FOREWORD

I am pleased to put into the hands of readers Volume-6; Issue-6: 2019 (June, 2019) of “**International Journal of Advanced Engineering Research and Science (IJAERS) (ISSN: 2349-6495(P) | 2456-1908(O)**”, an international journal which publishes peer reviewed quality research papers on a wide variety of topics related to Science, Technology, Management and Humanities. Looking to the keen interest shown by the authors and readers, the editorial board has decided to release print issue also, but this decision the journal issue will be available in various library also in print and online version. This will motivate authors for quick publication of their research papers. Even with these changes our objective remains the same, that is, to encourage young researchers and academicians to think innovatively and share their research findings with others for the betterment of mankind. This journal has DOI (Digital Object Identifier) also, this will improve citation of research papers. Now journal has also been indexed in **Qualis (Interdisciplinary Area) (Brazilian system for the evaluation of periodicals, maintained by CAPES)**.

I thank all the authors of the research papers for contributing their scholarly articles. Despite many challenges, the entire editorial board has worked tirelessly and helped me to bring out this issue of the journal well in time. They all deserve my heartfelt thanks.

Finally, I hope the readers will make good use of this valuable research material and continue to contribute their research finding for publication in this journal. Constructive comments and suggestions from our readers are welcome for further improvement of the quality and usefulness of the journal.

With warm regards.

Dr. Swapnesh Taterh

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Youth and Transitory: The Profile of IRPAA Residents and the aspects of their Training

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Abstract—This article aims to broaden the specificity of the historical approach that revolves around the discussion of "student republics" and "youth", as well as to develop theoretical/methodological considerations about the youth condition experienced by these young people. Ten (10) collaborators are used methodologically, with six (6) young people living and four (4) living in a student republic maintained by a non-governmental organization located in the city of Juazeiro, Bahia, where offer training opportunities in the context of living with the semi-arid region, which contrasts with the technical and vocational training under which they are subjected. It presents as main results the reflection that these young people who are of different origins, whether from the countryside with traditional bases (indigenous people, quilombolas, fishermen, family farmers, relatives, pasture fund, social movements, etc.) being the result of the process of construction of the subject, based on the juvenile hybridity, influenced by the transient movements, which is the main challenge to think about and propose formative processes that meet the specific needs of these subjects, whether in the educational field, social movements and / or human ecology.

Keywords—Training, Juvenile hybridity, Transient movement, Narratives.

I. INTRODUCTION

This article is an integral part of the master's dissertation produced in the Postgraduate Program in Human Ecology and Socio-Environmental Management, which is interested in discussing the relationships established by young people in their vocational training process and their future performance. These subjects live in a student republic maintained by a non-governmental organization located in the city of Juazeiro, Bahia, where they offer training possibilities in addition to their stay in the context of the semiarid coexistence. which are submitted.

Thus, the present work aims to broaden the specificity of the historical approach that revolves around the discussion "student republics" and "youth", especially when compared to the interdisciplinary approach, as well as develop some theoretical / methodological considerations about the condition young people lived by these young people, in which we are considering "transient youth" from the experience since its origin in the field and the relationship established by studying and residing in the Republic of the IRPAA.

Given this presupposition, the text in evidence takes as its centrality the displacements carried out by these young people in relation to the departure of their community and the arrival in formative spaces that are also linked to daily living and the relationships

established by it and constituting other horizons for their lives. We call this movement "transitory" and seek throughout the text to problematize this place of formative reconstruction for the life of young people.

As mentioned, the formative process is also due to the coexistence in the republic, so it is pertinent to signal that this terminology has several meanings and meanings, but the applicability in this text is synonymous with the hostel, boarding house, ticket house, student house. This definition is not demarcated by a specific date for its emergence, but, many scholars, link the first universities of Portugal and the houses created by the government of the same period. With Portuguese influence, Brazil had its first student republics in the state of Minas Gerais and spread in several capitals and interior of the country.

However, a model with characteristics different from traditional ones was created over 20 years ago in the interior of Bahia, in the region of the São Francisco valley, in order to provide non-formal training and enable the children of farmers to continue their studies, mainly technical training.

With a transition dynamic through which young people are submitted (coming from the countryside, going through technical training, going back to the field, and returning to the urban area in the majority), it causes us to think of a different condition experienced by them and

that reflect the formation, participation and professional constitution, the condition of transitoriness, which has contributed to the development of the rural and its communities, in a fair and sustainable way, thanks to the dynamics of the republic and the influences of the formative processes.

The discussion on "youth" has a vast conceptual field, in which its definition varies from biology, sociology, anthropology, political sciences, among other areas of knowledge, more basically the youth is understood as a phase in which the individual is in development, where spaces, orientations, positions, and conceptions, will define this subject, which is in constant changes and transitions.

The understanding of the conception of youth, in this case, is bound up with the factors and the cultural, social, customs or traditions perspectives in which this subject is inserted, where any result, whether harmonious or disharmonic, will result in a product distinct from so many others, however rich in meanings and subjectivity.

Still discussing in the epistemological field of the young subjects, the Food and Agriculture Organization of the United Nations considers that

There is no universally accepted definition of youth. Young people have been described in many different ways; sometimes as a particular age group, as a stage of life or as an attitude. [...] In its relations with governments and organizations, FAO uses a wide range of ages, depending on the specific definition of "youth" used within a particular country or a specific organization. The age range surprisingly ranges from 8 to 40. (FAO, 2002.)

Like the FAO and the UN, there is no concrete definition, just a concrete discussion as regards the age group for its definition "The UN Secretariat uses the terms youth and young people interchangeable to mean age 15-24 with the understanding that member states and other entities use different definitions".

However in the same discussion, there are exceptions, where in some countries they will have their standards, but in Brazil, there is a divergence, where several regiments, documents and institutions have their own definition of age group and arguments. The Statute of the Child and Adolescent - ECA, between the ages of 12 and 18 is incomplete, the National Youth Statute, from 16 to 29 years of age, and finally the Brazilian Institute of Geography and Statistics - IBGE and some governmental programs linked to agrarian reform establishes between 16 and 24 years of age. Just as in some countries and not

different in Brazil, youth is a more fluid category than a fixed age group.

It is important to highlight that methodologically this work consists of the construction of a diary of the daily experience of formation, memorials, interview narratives and interviews by depth, in order to build the profile of these young people. In order to maintain ethics, research confidentiality and shelter employees, we will use codenames of birds and fish of the caatinga, in order to maintain the climate and valorization of the natural context and to remember the transitional character of these animals, characterized by their comings and goings, in some migratory cases.

Thus, initially, we will discuss the paths and transitoriness of the young people's constitution, theorizing the identity steps throughout history and the constitution of the different youths, then we present the discussion that revolves around the republics, from its genesis, the terminological association to inns, exposing the history and types of republics (outside and within Brazil), reaching the model of republic located in the semi-arid Bahia. Finally, we present the perspective of transient youth, based on the institutional profile, through the voices of these young people.

II. TRANSITORY AND THE CONSTITUTION OF YOUNG PEOPLE

Youth can be seen in a number of different ways, which result in different youth policy strategies. Views of this period can be split into different phases. Youth can be seen as a transitional phase, a socialization phase, a struggle for social status or as a period with intrinsic value. There are differences between the different views, but they should not be exaggerated (YOUTH AND YOUTH POLICY – A SWEDISH PERSPECTIVE, 2010).

The citation in evidence, a fragment of a Swedish reference text, "Youth and Youth Policy - A Swedish Perspective," sums up, in a nutshell, the universality of youth and its multiple definitions, the same is a result of militant young people together with the Swedish National Council for Youth Affairs, which ensures that young people have access to influence and well-being. Thus, in this topic, we will discuss the concept of the word youth, which is a subject that is constantly discussed, mutated and present more and more in academic circles. We will try to make a genealogy about the historical conditions that have arisen on this subject. Considering the historical aspects and cultural partners trying to understand how this concept transpires to practice.

Many historians claim that youth as a social class only arose in the eighteenth century, Dick (2003) points out that the term juvenile was only officially categorized in this century where it definitively marked its limits in the history of mankind. Being interesting to transpose to make a provenance on the youth category for the understanding of some subjective elements contextualized in our western culture.

In the history of Ancient Greece, we understand how it initiated the obstacles of the Western structure in the way of thinking, organizing in society and of relationship. In the book *The Story of Young People*, a text by Alain Schnapp (1996) points out that for the Greeks cities were synonymous with a regulated social life. The Greeks treated young people as beginners in civic life, and everything concerning the polis was dealt with from the oldest to the youngest, with the basic conduct of Hellenic life as the ideal of beauty (pederasty, homosexuality) and war (the hunting games and physical exertion). Defining youth in this age as the beautiful and the strong are firmly establishing in their own body the most fundamental situations of their own life. Yet within this context, there is a counterpart with philosophy as names of Socrates and Plato that revolutionized Greek education and way of life.

Nietzsche, Socrates, and Plato bring a dualist interpretation of the world to explain the meaning of life and establish hierarchies of principles and values. Nietzsche (2001) brings a vision of Socrates on moral inversion, which creates a therapy to harmonize the Greek instincts giving particularity to the figure of the young. Finding it necessary to discipline the young man. Using this dialectic for the principle of self-assertion as an advent of defense, transforming the rule of beauty and strength into reason, virtue, and happiness. Passing everything by the evaluation of reason. Thus, in the face of two points of view of the cultural transformation of the beautiful and the force of human reason, we come to a new phase of Western humanity, opening a door to an interpretation of the construction of youthful subjectivity.

When we go to Christianity, we note that it springs from the context in which Greek culture is being transformed from the dialectic of Socratic reason to being apprehended by the Roman empire that later incorporates Christianity into its social scene as an official religion.

Christiane Marchello-Nizia (1996) points out that in the average age most heroes are young, or at least men with juvenile qualities. And when we look at the literature of this time we identify principles linked to love and prowess (chivalry and courtesy). Understanding that the values attached to young people in this stage of history are linked to the battlefield and cloister of the

monasteries. Society was centered on religious and educational institutions that focused on controlling the juvenile carnal passions that emerged most at this stage and the body was seen as an object of desire, in short, a culture turned to moralism.

Thus epistemologically we can define the word youth from several strands. By biology, it is understood in two initial stages: pre-adolescence (from 10 to 14 years) and adolescence (from 15 to 19 years). For sociology, youth is constituted as a young insecure aspect within the contemporary scenario of the future. Anthropology sees youth as an enriching cultural element. And history treats youth as a temporal, spatial and cultural variant depending on the society inserted (CLIMACO, 1991). The juvenile trajectories in the country came from the abolitionist movement in the XIX century, these young people intervened in the radical action for the liberation of the slaves (CACCIA - BAVA, 2004). In 1920 three movements in favor of political youth were inaugurated: the Movement of the Week of Modern Art; the Tenentista Movement and the political party movement that originated the PCB political party. According to Caccia - Brava (2004: 64): "Youth groups were formed around these movements and were protagonists of new ideas, new conceptions of nation and state".

We then had a youth organization with movements focused on nationality as a highlight the National Student Union - UNE and the religious movement around Catholic Action. According to Novaes (2000), the youths who belonged to the partisan and union organizations represented the working class. Highlighting the decade of 1960 that was when the youth began to have an emphasis on Brazilian society. But due to the political effervescence of the years that followed from the 60's because of the Military Dictatorship, the youth exerted an internal articulation of a spiritualist nature, and the young people who resisted this system acted in the clandestine social movements of armed struggle.

In the pre-1990s we come across a youth that is not utopian, according to Sousa (1999): "Intentions, utopias, projects, rebellions, transgressions are concrete elements in the relations lived by this age group, but isolated as behaviors of the young, is not explanatory of the relationships involving the youth" (IDEM, 1999, p.25). The social conditions of the youth of the 1990s are distanced from revolutionary methods, and what is noticed is an individualistic perspective.

As already mentioned, there is no exact universal age group to delimit this phase of life, so, as already mentioned, the most cited is used by various territories is between 15 and 24 years based on UNESCO and

especially the UN, "Youth and Young People, The UN Secretariat uses the terms youth and young people interchangeable to mean age 15-24 with the understanding that member states and other entities use different definitions (UN, s / d)", as mentioned, there will be cases in which the country or continent, will define on the basis of its statutes or regiments the initial and final age.

As previously mentioned, in relation to age range variations, in South Africa, the age group is between 14 to 35 years (OAU, 1996); in Canada, there are variations based on their geographical variations from 12 to 19, or in some cases from 15 to 19. The British say that there is no exact starting age but ends at 30 years. In Japan, young people are individuals up to 35 years of age (Chaves, 1999).

In other Western countries, they define the maximum age of youth for 15 years of age, but this will depend on the cultural aspects of each nationality. Youth is a category that in addition to being marked by adversity is a dynamic class. And from a new family, political and social conjuncture, the young person is inserted in a transitory society process.

However, some experts (PAIS, 2003; OLIVEIRA, 2014) consider youth as the transitions phase, the intersection between the responsibilities of children and adults in society, that is, assume a social role, going beyond an age group. However, official bodies such as the IBGE, determine from 15 to 24 years. The Youth Statute (BRAZIL, 2013) considers young people in Brazil to be all citizens between the ages of 16 and 29 and finally the Statute of the Child and Adolescent (ECA) establishes that adolescents are individuals between 12 and 18 years of age. In this way, we can consider some variants, divided into three stages: teenagers (between 15 and 17 years), young people (aged between 18 and 24 years) and young adults (25- 29 years old).

Completing the discussion and giving continuity, youth can be defined by their cultures, beliefs, ideologies (ideas, thoughts, doctrines, and worldviews) and origins (rural, urban and rururbano), or even by periods (golden years, hipers, painted faces, etc). that is, "[...] youth is a symbolic conception, representation or creation, made by social groups or by individuals considered as young, to signify a series of behaviors and attitudes attributed to them. (GROPPO, 2000, p.07).

Young people are living in constant changes and adaptations, inserted in a globalized / technological context that encompasses the fourth industrial revolution, with the use of computers, tablets and cell phones of last generation that end up canceling distances that previously

existed and giving access to all the types of information either for the field or for the city. "... because of its combination with other social situations - such as class or social status - and also due to cultural, national and local differences, as well as to ethnic and gender distinctions" (IDEM, 2000, p.15). Thus, mainly rural or rural youth, which was formerly marked by "ignorance" denial of rights, now traces a path of development in education, culture, and leisure.

It is known that there has always been the context of the exodus to the great centers in the longing for a better condition of life. In the youth field, we are currently seeking an insertion as a singular subject in its identity and plural constitution in its particular needs and thus we identify as transitional young people.

Aiming to broaden the discussion and enter the universe of the transience of young people, especially young people from the countryside and migrate to the urban in search of study/work, the new housing, where they have often shared environments, contribute to the construction of the identity of these subjects.

Life in the Republic: from the transitional to the social subject

The origin of the term "republic" has a genealogy of the Latin *res publica*, a word that can be expressed as a public matter or public thing, which denotes the idea of a public good, of what is collective (LAFER, 1989). The regime approached by the Roman Empire was also used to classify the city-states of Greece, or the regime instituted by Oliver Cromwell in the seventeenth century in England (MENDÉS-FRANCE, 1963). However, the modern conception of the republic (based on a head of state and the division of powers) only arose after the strengthening of liberalism.

Thus, republican terminology has gained adjectives and has been associated with student housing, student houses, boarding houses, pension or Brotherhood, however there are several assumptions (REPOLÊS, 2007), so these types of housing are composed of groups of young people, mostly of the times they are from distant localities and move in search of study (MACHADO, 2013a).

With regard to the first records on republics, there are several versions, the most cited being that in the fourteenth century in Coimbra, Portugal, when D. Dinis, by royal diploma of 1309, required the construction of houses should be inhabited by students in the area of Almedina, by means of a fixed payment of a rent, administered by a commission appointed by the King, composed of students and "good men" of the city. In this way, these types of accommodation made possible the

universality of higher education, allowing young people from various localities to continue their studies.

Already in Brazil, the student republics have their origin from the first faculties created in the regency of Dom João IV, such as the Faculty of Medicine in 1808, more ahead with Dom Pedro II, with the implementation of the School of Mines in Ouro Preto in 1876, became the center of student life, incorporating tradition, history and customs (IDEM, 2013c). Thus, near the School of Mines, student republics were created, in the same models as those in Coimbra, noting that the houses were owned by the School, with the change of capital to Belo Horizonte in 1890, and the responsibility and maintenance of students, assigning a small rent. (IDEM, 2013b).

In this way, the republics of Ouro Preto in Minas Gerais are called unique in Brazil (MALTA, 2010), thanks to their peculiarities, said to be unequalled to other university cities, having the characteristics of student dwellings, with their tradition, history, and constitution of structure, similar) to the republics and solar of Coimbra, in Portugal.

Other relevant information for this discussion is the creation of the first republic outside the country, destined to the Brazilian students in Paris, called "house of the students" created in 1928, located in Paris, and directed to assist students studying in the capital of France and had difficulty staying in the city (COSTA, 2010).

With the passage of time, the student republics have been multiplying over the years and Brazilian territory, adding the most diverse types of education, from elementary and secondary education, an example from the perspective of the pedagogy of alternation, as well as technical education offered by technical schools and federal institutes and, finally, in the higher education, from state to federal institutions, in which

[...] some units of university residences, where all the infrastructure was made available, such as furnished rooms and appliances, while in others it is a grant destined to the payment of housing expenses with varying amounts (IMPERADOR, 2017, p. 295).

Thus, there is a diversity of types of republics, in which part of them are part of the student assistance plan, where the institutions offer housing (inside or outside the institution) maintained by the same and in another case, the houses are maintained by the students themselves with the help of family assistance or help. Thus the republics or housing destined to young people of other localities that go in search of continuing their studies, they have been in Brazil and for centuries and lately has extended and gained the interiorization in diverse regions and states.

A model of a republic, located in the semi-arid state of Bahia, which has been in existence for more than two decades and annually receives groups of young people from the countryside and traditional communities, who migrate in search of continuing their studies, for the regional and local development of the subjects' communities. Being the host, the centrality of this study, since it has unique characteristics of the models described throughout this material, giving rise to a term called Transient Youth, which will be detailed later.

To enter the context of the republic that we will discuss, we initially introduce the institution that administers the same. The IRPAA, or rather, the Regional Institute of Appropriate Small Farmers, founded almost 30 years ago, is a non-governmental organization based in the municipality of Juazeiro-BA, which develops awareness-raising and awareness-raising activities through educational projects and concrete actions to the coexistence with drought is the semi-arid (OLIVEIRA, 2005; CARVALHO, 2008; OLIVEIRA, 2014).

Once, the IRPAA became a reference in studies and training, to coexist with the semi-arid region, it was necessary, the expansion of its facilities as well as the creation of a center for the accomplishment of the formations, so in 1994, the center was created Dom José Rodrigues or popularly known as the IRPAA farm, located 12 km from the city of Juazeiro-BA, in the Jardim Primavera district on the 30-hectare Tourão farm, the area has an auditorium, dormitories, dining room, as well as experiments various types of cisterns, processing plant, vegetable gardens, animal husbandry, Barreiro, etc.), all this structure is the basis for various events (meetings, seminars, conferences, etc ...), and can accommodate up to 60 people .

In addition to the prospect of a training space, the institution added the farm to a republic formed by two houses (female and male), destined to receive youngsters from the countryside, children of farmers from several Brazilian semiarid localities , which have partnerships with partner institutions that seek to enter technical or higher courses in the agrarian / environmental area. On the other hand, the institution offers an informal formation in several areas and abilities, aiming to develop the critical, political sense for new horizons and especially for the conservation and coexistence with the caatinga and semiarid biomes.

The maintenance of the countryside and the republic are carried out by the young residents, who carry out conservation activities such as cleaning, weeding, feeding, composting, among other activities, at times that do not jeopardize their studies. The source of support in

the institution is through sponsorship scholarships (SILVA, 2004, p.27), to keep personal costs and not to induce young people to seek work and focus only on studies. In addition, in signing the agreement with the IRPAA, an agreement is made with the youth, in which, after completing the course, they must return to their communities and during a period, they must make a return, as it is presented in some narratives of the following employees:

"[...]por outro lado, eu estava com a formação técnico em agropecuária, então meu pensamento foi que, ali seria o momento em que eu iria voltar para minha terra, pra contribuir[...]" (PACUMÁ, memorial de formação, 2018).

"[...] o acordado entre o IRPAA e a instituição que nos indicam, que no final do curso técnico, retornamos para repassar os conhecimentos e aplicar em nossa comunidade, [...]" (DOURADO, diário do cotidiano., 2017).

The republic supports 24 young people at the most, who make casters to visit their communities, especially on commemorative dates, to visit relatives. Thus, every year a new group arrives and another leaves the institution. In this dynamic of comings and goings, with the fixation of a period in the communities, they generate a transience, in which I denominate of "transitory youths". Thus over more than 23 years, more than 150 young people have passed, who have a group and a generation, with great responsibility for the development of their bases.

Who are the young residents of IRPAA: aspects of transitoriness and training

The northeast region is known for its great territorial extension, besides sheltering most of the Brazilian states, a region rich in cultural, climatic and geographic diversity, has a great variety of biomes, among them the Atlantic forest and mangrove (littoral), Amazon forest (west of the region), forest of cocais, closed and with greater extension and predominance the ecosystem with characterized semi-arid, called caatinga biome, in which an image and stereotyped visions have been always transmitted mainly in the interior and in the field, of a place of delay and miserable people, illiterate and malnourished, cracked ground, dead animals, with a belief that nothing was right here, for it was the will of God. With only one direction remaining, they migrated to the cities, which were synonymous with progress and modernization, and for decades, especially in the great droughts, thousands of northerners sought the metropolitan regions, especially in the southeast, as an alternative to get rid of the droughts.

With this, several actions and programs were implemented by governments, aiming to eradicate and combat drought, such as DNOCS and SUDENE, among others, but the actions saw that the drought was something negative and should be stopped at any cost, not seeing that is a natural phenomenon of this region. Thus, in the last three decades, actions have been taken to coexist, in particular with civil society organizations, social movements, family farmer organizations, peasants and leaderships (COSTA, 2017), creating a new paradigm in logic of the Coexistence with the Semi-Arid, which assures the perspective of the Good Life, through a sustainable relation of human beings and nature "(IDEM, 2017.p. 95)

The initiative to create the institution was given by Bishop José Rodrigues of the Diocese of Juazeiro, who followed the ideals of living well, and against some governmental proposal (against drought), as well as militant for the causes of the least favored in the field and in the city, in which organizations and international cooperation together with the Community Ecclesiastes of Bases - CEB's, initiated a collective of local and regional actions, with the aim of minimizing the consequences of the prolonged drought.

In this context, in April 1990, the Regional Institute for Appropriate Small Farmers - IRPAA, an organized, nongovernmental and nonprofit civil society organization legally ruled by an association, with representatives of dioceses, farmers and regional leaders, which at first draws on the experiences and ways of life of rural communities and, in the first instance, formulates a different proposal for this region, based on local knowledge, identifying potentialities and fragilities, learning from nature to deal with the adverse situations of climatic oscillations, respecting the local specificities, valuing the culture of a strong and resilient people, people of great faith and belief, that even with the marked rural exodus, still hopes for better days in the countryside.(COSTA, 2017, p.88-89)

With the creation of the IRPAA, several aspects related to the coexistence with the geographical, biological and climatic context, began to be seen in other ways, from "wretched drought" to "a climatic reality in which we must live and seek means to survive" this is the mission and militancy of the IRPAA, organized in three periods (1990-1999, 2000-2009 and finally 2010-2017) of the institution's actions since its inception,

1. Between 1990 and 1999: institutional strategy was the construction and dissemination of the proposal of Living with the Semi-Arid (IDEM, 2017, P.89);

2. Between 2000 and 2009: in defense of an appropriate public policy for the Semi-Arid (IDEM, 2017, p.93).
3. Between 2010 and 2017: a strategy under construction today, it runs through the Consolidation of Coexistence with the Semi-Arid (IDEM, 2017, p.94).

Returning to the previous subtopic, with the creation of the IRPAA, the training center Dom José Rodrigues (initially named only as an IRPAA site, in honor of the founder, is now named) was added to the physical spaces as a structural part of the where it serves as a laboratory and training center for the coexistence with the semi-arid. Taking advantage of the space, in addition to the international initiatives, the creation of a republic aimed at receiving the children of farmers and traditional peoples was implemented in the same space, in order to continue the studies (technical and University graduate).

Over 24 years (1994-2018), hundreds of young people passed through the republic of the institution, sharing and disseminating the principles and ideas for coexistence with the caatinga biome, between comings and goings, trebled and guided a Good Living mission. For the construction of this research, ten collaborators participated, among them six young people residing in the republic and four who lived and went through the process of formation.

The following are the collaborators, using codenames to guarantee the research ethics and protect the subjects. For this moment, we will use excerpts from the diary of daily training experience, memorials and narrative interviews and by depth, for their presentation. For this, we will use names of species of fish and birds of the caatinga, since they are animal synonyms of resilience, strength and its transitional character of comings and goings.

Initially we present the students Tiziu, Asa-Branca, Surubim and Pacumã, you can observe that this one has as similar the passage and experience in the republic and the constitution as professionals starting from these experiences.

Natural de uma comunidade rural chamada Lagoa da Roça, município de Campo Formoso na Bahia e criado pelos avôs maternos, desde cedo fui instruído a participar dos espaços religiosos, igreja católica, e espaços coletivos de discursões na comunidade, associação comunitária, além do envolvimento nos trabalhos da roça onde plantávamos feijão, milho, mandioca, batata, guandu, abobora, melancia e nos dias de sábados íamos vender esses produtos na feira livre do município.” (TIZIU, MEMORIAL DE FORMAÇÃO, 2018)

Eu Asa Branca, 35 anos, filha adotiva de pequenos agricultores camponês, Maristela Santos de Santana e Edmundo Ferreira residente e domiciliada na comunidade Itapicuru Monte Santo Bahia, venho através deste relatar minha trajetória de vida pessoal e profissional. [...] desde muito cedo, quando ajudava meu pai nos trabalhos da roça e participava dos acontecimentos e iniciativas populares junto a minha mãe professora, líder comunitária e defensora de uma classe oprimida, a qual tanto almejava um grande sonho, juntamente com varias tantas outras lideranças dar-nos, apoiar-mos enquanto filhos de agricultores(as) do campo uma educação qualificada que defendesse e discutisse a realidade, a vida do jovem camponês. (ASA-BRANCA, MEMORIAL DE FORMAÇÃO, 2018).

eu sou Surubim , tenho 24 anos, acidente geográfico Chorochó-Bahia, Escorpiana, carrego comigo sangue indígena, mistura com mulatos, minha biza era índia os trukas, técnica em agropecuária, mãe do Miguel, venho da comunidade Alto Vermelho município de Abaré, BA, comunidade qual é reconhecida como fundo e fecho de pasto, filha de agricultor e agricultora, venho da luta, fiz parte dos movimentos sociais, fiz parte também do grupo gau: grupo de agroecologia Umbuzeiro, que fina na Universidade ENEB/Juazeiro, em 2014 fiz parte da república do IRPAA (SURUBIM, MEMORIAL DE FORMAÇÃO, 2018).

Sou Pacumã, sou filha de agricultores familiares, minha mãe e meu pai, sempre trabalharam na roça, assim como os meus avôs, tanto materno como paterno, [...] meu pai sempre trabalhou na roça, tanto na cultura do cajueiro, [...], eu não tinha condições de ir e nem me manter naquele momento, pois no primeiro ano não teria a bolsa [...] meu tio avô, disse que me ajudaria naquele momento, [...] meu tio e minha mãe me deram apoio [...] eu fui com meu primo e um colega da comunidade [...], que também fizeram parte da república [...] (PACUMÃ, MEMORIAL DE FORMAÇÃO, 2018).

In narrating and presenting themselves, the young people make a movement to meet the various temporalities that constitute them and are signifying the dimension of transience that we are referring to throughout the text. We will continue presenting the narratives of the current students who live in the republic of the IRPAA and composes the transitory movement in these subjects and their spaces.

Desde à infância, fui menino de igreja, menino comum, igual a todos mas, religioso, isso se deve ao incentivo de minha mãe, embora não muito religiosa, sempre levou-me à encontros de grupo, reuniões das quais participava, tudo isso ligado à igreja Católica. [...] até fundador de um grupo de

oração e outro de canto e sendo membro de um grupo de Jovens. [...]Canudos; cidade histórica, [...]cidade de gente simples e acolhedora que mesmo com influencia midiática e com as políticagens partidárias, tentam manter o espírito de fraternidade (CABURÉ, DIÁRIO DO COTIDIANO..., 2017)

Sou da comunidade Caraiba de Senhor Teixeira, município de Pilão Arcado em minha comunidade mora só família tem seis casas. Praticamos atividades voltadas a agricultura e pecuária onde criamos gado, ovelhas, cabras, galinhas, produzimos farinha, tapioca, etc. o que me trouxe a esse curso foi a necessidade técnicas em agropecuária em minha região além de ser uma área que me identifico[...]. Na minha comunidade eu trabalhava como catequista e nas comunidades vizinhas por a igreja católica participava de encontro que era promovido por a paróquia Santo Antônio em Pilão Arcado onde vinha jovem do município todo no centro de formação Palmeiras de Elim onde tinha encontro de estudos de bíblia, assembleias entre um espaço muito agradável[...]. Também sempre gostei de participar de reuniões de associações ou qualquer do tipo. Sempre participei de reuniões promovidas pelas entidades IRPAA e SASOP[...].dos encontros promovidos pela pastoral da Terra-CPT que também me ajudou a escolher cursar agropecuária onde eu já tinha conseguido um vaga para estudar na EFAS de Monte Santo[...](PIAU, DIÁRIO DO COTIDIANO..., 2017)

Sou azulão, venho do interior de Campo Formoso, tenho 21 anos (Jardel), filho[...], tenho duas irmãs[...].ambas mais novas. Mãe é dona de casa e também trabalha na roça, pai trabalha em construção civil[...].terminei os estudos em 2014 foi quando comecei a trabalhar mais meu pai, na construção civil. Trabalhei dois anos com ele. [...] venho de uma família simples do interior de campo formoso, onde fui criado pelo meus pais com a ajuda de meus avós paterno, uma infância um pouco difícil por não ter condições financeiras[...], fiquei sabendo do IRPAA através do meu tio que, morou na república. (AZULÃO, DIÁRIO DO COTIDIANO..., 2017)

Sou arribaçã, tenho 21 anos e venho de uma comunidade indígina da tribo tuxi do município de Abaré-BA. Ainda sou agricultora, índia e atualmente estudante do curso de engenharia agrônômica e filha de agricultores na qual o principal sustento foi o manejo com a mãe terra, desde aos 11 anos comecei com trabalhos de grupos na igreja de minha comunidade e logo depois com o passar do tempo com a causas indígenas do meu povo tuxi. (ARRIBAÇÃ, DIÁRIO DO COTIDIANO. 2017).

Sou carcará, de uma comunidade quilombola, [...] do povoado de Tamandua, [...], tenho orgulho de ser remanescente de quilombola de um povo resistente, lutador que mesmo com o sofrimento conseguem manter-se forte e luta por seus direitos, que durante muito anos foram negados[...](CARCARÁ, DIÁRIO DO COTIDIANO..., 2017)

Meu nome é dourado, tenho 20 anos,[...] somos 3 irmãs,[...] já moramos em Brasília por oito anos e voltei em abril de 2008, foi quando terminei a 4ª série, em Lagoa de Eduardo, comunidade de Pilão Arcado, mais eu moro em sítio Geraldo,[...] porém tive que repetir de ano, pois minha mãe achava que não estava preparada para a 5ª série[...].das três irmãs, uma faz pedagogia, e a mais nova esta parada, pois mão não tem condições de pagar,[...] a minha vinda para IRPAA, foi graças a colega, que estuda em Monte Santos, na EFA, que é da comunidade, que falou, [...] eu era secretaria da associação, [...] ai o gerente pastoril me indicou a associação de fundo de pasto, que me indicou, [...] eles viram o meu envolvimento na comunidade,[...] antes de vim, eu estava preocupada, vou terminar o ensino médio e vou fazer o que,[...]os professores perguntava o que a gente ia fazer, qual faculdade, mais a gente não sabia[...]. (DOURADO, DIÁRIO DO COTIDIANO..., 2017)

As seen, a good part of those who have lived or lived in the republic have some common characteristics, among them the origin of social movements, traditional communities (countryside, fishermen, natives, quilombolas, farmers, among others) or relationship with the church or related groups. Given that all share ideals, customs, cultures, habits and practices, aimed at a sustainable and ecologically correct culture, so those involved with the Republic are constantly training, mainly informal and non-formal, due to diversity the coexistence and the policies of the institution.

It is these aspects that make it possible to think of transitional young people who are initially constituted by the profile traced by the institution when creating inclusion criteria, based on the internal regiments, terms of adhesion. These young people come from traditional communities, be they fishermen, quilombolas, natives, pasture fund, families that live from fruit extractivism, family farmers

However, there are exceptions, some young people who passed through the republic were indicated by social movements, linked to the church, as the case of the young Caburé, who comes from the municipality of Canudos-BA, by indication of the Catholic Church and CEB. thus, the criterion of being of small municipalities, with a

culture / commerce directed to the field, where some scholars, show that the expansion of these spaces, gave origin to small villages, and in turn, in small municipalities, in which, it is still a developed rural environment, as some authors often call urban-rural (BERNIERI, 2002; REIS, 2006). Thus, for this study, the young people of the republic are always associated with the field, since the centrality, besides the processes of formation, is destined to this subject profile.

Transient movements and young people as a social subject

the juvenile phase is characterized by a gradual transition to the full assumption of adult roles in all societies, both rural and urban (DURSTON, 1994, p.14)

The movement of going and coming from the countryside to the city and vice versa is composing a hybrid process of identity constitution in these subjects, often leading them to stay in the city and never finish high school, entering the field of work, especially if we take into account that for young people living on the farm the entry into adulthood occurs much earlier. (OLIVEIRA, 2014).

In both fragments, the category of transience is strong and associable with youth, as if nature tends to a process of changes and adaptations. Thus, to deepen the discussion of a specific group (young people of the IRPAA republic) it is necessary to enter into the epistemological universe of some terms and categories, for a better understanding.

The fragment quoted above, Oliveira, deals with some of the characteristics of the young people who live or who have passed through the IRPAA republic, where the construction processes (identity, gender, professional) associated with the cultural diversity of the spaces in which young people are inserted IRPAA and CETEP), besides the comings and goings of their communities, in addition to the subjective and personal transformations, causes in a new reflection on itself, in which the author identifies as a process of hybridity.

These processes of insertion and influence of several patterns in which we denominate of hybridity, (comes from the Greek Hybris) refers to the mixture of things of different orders, resulting in the excess. The term "hybrid" is also associated with "mestizo" and "heterogeneous" (MADEIRA, 2010, p.2). Where the hybrid occurs as a "[...] process of diversification through mixing [...]" and not "... as a process of homogenization". (IDEM, 2010, p.4) "to name some objects, practices and processes of our contemporaneity, only the word hybrid seems to serve to give some reference to experience. The hybrid invades our daily lives." (IDEM, 2010, p.1).

As Durston says, the transition in the juvenile phase occurs in both rural and urban areas, this movement is more visible and strong when we deal with young people from the countryside who are often in contact for the first time with an urban culture / globalized. This movement between comings and goings (republic-school, republic-community) of the youth of the republic, contribute to the movement of hybridity, reconfiguring the individual, giving the opportunity to re-evaluate his role as subject in that community.

To think of the youth that inhabit the republics of the IRPAA is a transitional condition, which is directly related to the development of the individual (young), initially marked by its history, religion, culture and customs and has direct cultural and social influences from the context in which it is inserted. In addition, other influences are constant in the life of the IRPAA youth, they are experiencing a training phase, which in this case of two institutions, where the CETEP (technical course = formal) and the IRPAA internal, training, courses and mini-course = non-formal), which introduce multiple knowledge and ideologies in the residents, where they are processed, decoded and passed on or reproduced in their social circles.

The following is a sequence of narratives that characterizes the transitory movement that constitutes these young people,

[...] eu tinha uma visão sobre a sociedade, sobre tudo, com a minha vivência aqui no IRPAA, as formações, até mesmo alguns disciplinas no CETEP, eu pude mudar o meu ponto de vista,[...], a formação política como exemplo,[...]quando eu fui na folga a minha comunidade, já via com outros olhos a postura de meus amigos, que é muito machista, homofóbicos, e não é desse jeito, todos são iguais e tem o mesmo direito, ao voltar para república, pude ver o quanto mudei para melhor. (AZULÃO, DIÁRIO DO COTIDIANO, 2018)

[...] hoje eu surubim, estou contribuindo, com meus conhecimentos adquirido no IRPAA e CETEP, na cooperativa de Uaua, Curaça e Canudos COOPERCUC; na região de Curaça em um território quilombola, que é o quilombo de Valdemar, na Nova Jatobá, tem pouco tempo, mas já tenho projeto, para a comunidade e confesso diante de tudo que passei, dei um tapa na cara da sociedade, a quem não esperava por isso; to dando o melhor de mim, que não é pouco, rrsrsrs...to muito feliz a pesar que demorei muito para exercer a minha profissão mas tudo no tempo de Deus (SURUBIM, DIÁRIO DO COTIDIANO, 2018)

Based on the reports, we observe that from a different point of view, the experience and coexistence in these spaces, go to a transformation, which occurs every time

and round, evaluations and reevaluations and, finally, reflection.

With all the elements mentioned here, we believe that specifically related to these young people who are of different origins, whether from the field with traditional bases (indigenous, quilombolas, fishermen, family farmers, relatives, pasture fund, social movements, etc.), constitute as transient young people, which is the result of the process of construction of the subject, from the youthful hybridism, influenced by the transient movements.

Returning to the discussion, the transitional term, discussed by Oliveira (2014) in his master's thesis, is amplified and strengthened here. For a better understanding, the term is associated with something that is in constant movement, is in a transversal process, passing through other processes and movements. In this way, I see the young people of the IRPAA in a process, totally different from other young people who find themselves in the same dynamic, residing in republics, but these with subjectivities and interlaced in different ways.

III. CONCLUSION

The daily life revealed by these young people in narrating and reflecting on their youthful condition, a condition that corroborates with that presented by Dayrell (2003) in linking the debate to the dimension of transient as a possibility of "becoming", so also the young people are gradually becoming stronger and weaving learning that allows them to present themselves not only with a fixed age that determines whether they are young or not, it is beyond a category that is becoming distant from the ways of living and being in society, present themselves as constructors of their formative processes and in this way consider each element as meaningful for them to advance and assume the social roles and functions before their personal and professional performance.

As a result of these questions I return here the purpose of this writing. We propose to this end that the aim was to broaden the specificity of the historical approach that revolves around the discussion of "student republics" and "youth", especially when compared to the interdisciplinary approach, as well as to develop some theoretical / methodological considerations about a youthful condition experienced by these young people, in which we are considering "transient youth" from the experience since its origin in the countryside and the relationship established by studying and residing in the republic of the IRPAA.

What jumps in the reading of the narratives and the contact with these subjects is that the transience that constitutes these young people is delineated by subjective questions that are present in their identity marks and allow of this way to reflect the movement of coming and going, present in its trajectory in which they are led to leave their homes, the family's bosom, what is considered a "comfort zone", to live the different, the unpredictable, yet is not characterized as a permanent element, there is a presence of ephemerality that marks this transitory movement they live.

Beyond these aspects, it is pertinent to elucidate that in its narratives the place of transitory as a movement of construction and identity reconstruction is reinforced and is configured as a possibility of dialogue with its formative process. Dayrell, points out that,

On the other hand, we find ourselves in daily life with a series of images about youth that interfere with our way of understanding young people. One of the most ingrained is the youth seen in their condition of transience, in which the young is a "coming to be", having in the future, in the passage to adult life, the meaning of their actions in the present. From this perspective, there is a tendency to view youth in their negativity, which has not yet come to be (Salem, 1986), denying the present lived. This conception is very present in the school: in the name of the "coming to be" of the student, translated in the diploma and possible future projects, tends to deny the lived present of the young person as a valid space of formation, as well as the existential questions which they expose, far wider than just the future (2003, pp. 40-41).

Corroborating with the author's point of view, we come to the conclusion that youth can not be thought of, especially those present in rural territories or in the countryside, as the narrators of this research point out, as a mere temporal clipping or as a prognosis for the future. They come to live in the present time and their formative nuances as possibilities of self-affirmation and recognition are social subjects and the transitory here is only demarcated as the cut in the time in which they leave their zone of comfort and migrate to other spaces in search of growth and knowledge, in this case of vocational training, but which does not define the inherent aspects of its future or the denomination as subjects.

Young people come to recognize themselves as subjects and in this way are endowed with plans and plans for the future and, mediated by this transitory, temporary movement in which they demarcate their youthful condition, not as the reflection of a near future. Let us see what this young woman says,

[...] hoje eu penso diferente, quero terminar o curso técnico e fazer faculdade em zootecnia e dar um futuro diferente a minha comunidade,[...], aquela caracara que chegou aqui antes, não existe mais [...](CARCARÁ, DIÁRIO DO COTIDIANO, 2018)

In view of the above, we believe that with all the elements mentioned here, specifically related to these young people who are of different origins, whether from the field with traditional bases (indigenous, quilombolas, fishermen, family farmers, family, pasture fund, social movements, etc.), constitute as transitional young people, being the result of the process of construction of the subject, based on the youthful hybridity, influenced by the transient movements, what constitutes the main challenge to think about and propose formative processes that meet the specific needs of these subjects, whether in the educational field, social movements and / or human ecology, as we propose to articulate throughout the article.

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REFERENCES

- [1] BERNIERI, M. J (2002), Diversificação de Atividades no Espaço Rural: turismo, mais um componente para o desenvolvimento local? Vila Real: Dissertação de Mestrado, Universidade de Trás-os-Montes e Alto Douro/Universidade de Santiago de Compostela.
- [2] Brasil. (2013)Estatuto da Juventude (2013). Estatuto da juventude : atos internacionais e normas correlatas. – Brasília : Senado Federal, Coordenação de Edições Técnicas. 103 p.
- [3] CACCIA-BAVA, Augusto et. al. (2004) Jovens na América Latina. São Paulo: Escrituras.
- [4] CARNEIRO, M. J. T. (1998) O ideal rurano: campo e cidade no imaginário de jovens rurais. In Silva, F.C.T.; Santos, R.; Costa, L.F.C. Mundo Rural e Política. Ensaios interdisciplinares. Rio de Janeiro: Mauad.
- [5] CARVALHO, L. D. (2008) NATUREZA, TERRITÓRIO E DESENVOLVIMENTO RURAL NO SEMI-ÁRIDO BRASILEIRO: ESTUDO PRELIMINAR DAS AÇÕES DA ‘CONVIVÊNCIA COM O SEMI-ÁRIDO’ EM JUAZEIRO – BAHIA. Anais do 3º ENCONTRO DA REDE DE ESTUDOS RURAIS, UFCG, Campina Grande (PB).
- [6] CHAVES, E. O. C. Jr. (1999) Políticas de juventude: evolução histórica e definição. In N. Shor, M. S. F. T. Mota & V. C. Branco (Orgs.), Cadernos de juventude, saúde e desenvolvimento (pp. 41-48). Brasília: Ministério da Saúde, Secretaria de Políticas de Saúde.
- [7] CLÍMACO, A. A. S. (1991) Repensando as concepções de adolescência. Tese (Doutorado), Pontifícia Universidade Católica de São Paulo, São Paulo. 1991.
- [8] COSTA, S. G. (2010) A equidade na educação superior: uma análise das Políticas de Assistência Estudantil. Dissertação (Mestrado em Sociologia) — Universidade Federal do Rio Grande do Sul, Porto Alegre.
- [9] COSTA, T. P. (2017) A CONVIVÊNCIA COM O SEMIÁRIDO COMO PARADIGMA SUSTENTÁVEL NA PERSPECTIVA DO BEM VIVER. REVASF, Petrolina-PE, vol. 7, n.12, p. 79-100, abril.
- [10] DAYRELL, J. (2003) O jovem como sujeito social. Revista Brasileira de Educação. Set /Out /Nov /Dez. p. 40 - 52.
- [11] DICK, H. (2003) Gritos Silenciados, mas evidentes. Jovens construindo juventude na História. São Paulo: Edições Loyola.
- [12] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. FAO Rural Youth Developmet. <http://www.fao.org/rural youth/faq.html>. Acessado em 30/06/2018.
- [13] GROppo, L. A. (2000) Juventude: ensaios sobre sociologia e história das juventudes modernas. Rio de Janeiro: DIFEL. Coleção Enfoques Sociologia.
- [14] IMPERATOR, T. K. (2017) A trajetória da assistência estudantil na educação superior brasileira. Serv. Soc. Soc., São Paulo, n. 129, p. 285-303, maio/ago.
- [15] LAFER, C. (1989) O Significado de República. Rev. Estudos Historicos, Rio de Janeiro, vol.2, n.4. p.215-224.
- [16] MACHADO, O. L. (2013a) As repúblicas estudantis. En Lemos, Paulo A História da Escola de Minas. Ouro Preto-MG (Brasil): Legraphar.
- [17] MACHADO, O. L. (2013b) Escola de Minas de Ouro Preto: Memórias dos seus ex-alunos. Frutal-MG: Editora Prospectiva.
- [18] MACHADO, O. L. (2013c) República Aquarius: a maior república estudantil das Américas. Frutal-MG: Editora Prospectiva.
- [19] MALTA, E. (2010) Identidade e práticas culturais juvenis: As Repúblicas estudantis de Ouro Preto. Dissertação (Mestrado em Ciências Sociais). UFS - Universidade Federal de Sergipe. São Cristóvão. 2010.
- [20] MARCHELLO-NIZIA, C. (1996) Cavalaria e cortesia. In: LEVI, Giovanni; SCHIMITT, Jean-Claude (Orgs). História dos Jovens 1: da antiguidade a era moderna. São Paulo: Companhia das Letras. P:141 - 190.
- [21] MENDÉS-FRANCE, P. (1963). A República Moderna (Trad. De C.M.M e Maria Manuel), Lisboa, Europa-America. P.229-252.
- [22] NIETZSCHE, F. W. A. (2001) Gaia ciência. Tradução, notas e posfácio de Paulo Cezar de Souza. São Paulo: Companhia das Letras.
- [23] NOVAES, R. R. (2000) “Juventude e participação social: apontamentos sobre a reinvenção da política”. In ABRAMO, H. W. et. all (org.) Juventude em debate. São Paulo: Cortez.
- [24] OLIVEIRA, A. D. (2014). Jovens no Semiárido Baiano: Experiências de Vida e Formação no Campo/ Adelson Dias de Oliveira. Salvador.

- [25] OLIVEIRA, L. M. S. R. (2005) EDUCAÇÃO RURAL E DESENVOLVIMENTO LOCAL SUSTENTÁVEL: A Lógica Subjacente das Relações Inter-Setoriais. BELÉM-PA.
- [26] Organização da Unidade Africana (OUA) – (1996) Análise Situacional da Juventude em África, Documento apresentado na Conferência Pan Africana sobre Juventude e Desenvolvimento Adis Abeba, Etiópia: Comissão Econômica para a África.
- [27] PAIS, J. M. (2003) Culturas juvenis. Lisboa: Imprensa Nacional-Casa da Moeda.
- [28] REIS, N. G. (2006) Notas sobre Urbanização Dispersa e Novas Forams de Tecido Urbano. São Paulo. Via das Artes.
- [29] REPOLÊS, M. F. S. (2007) A identidade do sujeito constitucional no Brasil: uma visita aos seus pressupostos histórico-teóricos na passagem do Império para a República, da perspectiva da forma de atuação do guardião máximo da Constituição.. In: XVI Encontro Preparatório do Conpedi, 2007, Campos dos Goytacazes - RJ. Anais Conpedi / Campos dos Goytacazes.
- [30] SCHNAPP, A. (1996) A imagem dos jovens na cida de grega. In: LEVI, Giovanni; SCHIMITT, Jean-Claude (Orgs). História dos Jovens 1: da antiguidade a era moderna. São Paulo: Companhia das Letras. P:19 - 57.
- [31] SILVA, V. (2004) Sertão de jovens: antropologia e educação. São Paulo: editora Cortez.
- [32] SOUSA, J. T. P. (1999) Reinvenções da utopia: a militância política de jovens dos anos 90. São Paulo: editora Hacker.
- [33] YOUTH AND YOUTH POLICY – A SWEDISH PERSPECTIVE. Suécia, (2010) https://www.mucf.se/sites/default/files/publikationer_uploads/youth-and-youth-policy.pdf. Acesso em 09/07/2018.

Cooperation and Competitiveness in Brazilian Crafted beer Production: The case of gypsy breweries in Goiás State

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Abstract— This paper aimed to present and discuss the craft beer production in Goiás state, Brazil, where brewers do not own the necessary equipment (gypsy breweries). Therefore, a literature review combined with qualitative interviews with gypsy brewers were carried out. The industrial and crafted forms of production have not been annulled, and forms of production have arisen that involved processes of sharing the infrastructures of large companies and crafted producers, as in the case of gypsy breweries, cuckoo or ghosts. The practices of gypsy breweries, therefore, left Europe and gained the world, and came to materialize in Goiás, Brazil. A country that stands out in the production and consumption of beer. Among the main positive aspects of the practice of gypsy brewing in Goiás, it was possible to perceive the stimulation of diversified consumption, the possibility of using equipment in a more efficient way, taking advantage of moments of vacancy, sharing knowledge, and stimulating improvement in the quality of production, and, among the main bottlenecks are the distribution structures of production, and, the existing taxes in Brazil.

Keywords— *crafted beer, gypsy breweries, cooperation, competition.*

I. INTRODUCTION

Patrick McGovern in his book “Uncorking the Past” points out that interest in accessing alcohol may have led men, hitherto, hunters and gatherers to plant cultivation and thus cease to be nomadic. In his research, the archaeologist was in different points of the world evaluating through biomolecular research traces of boilers, to verify the consumption and search for the extraction of alcohol under various forms in different cultures around the world.

The consumption of alcohol, therefore, has always been linked to human customs, and the advances of production and access to alcohol have been diverse throughout the history of humanity. These advances are linked both to the act of producing, to the distribution and forms of organization and management of production.

The study and mastery of fermentation and refrigeration techniques facilitated the production of alcoholic beverages on a large scale.

This article deals with the production of alcohol, specifically beer, and brings elements that support us to reflect on how the relations of production sometimes

point to a complex reality that advances and makes ponder over the conceptual issues. In this article, we focus on how beer production came about, gained scale, and reached the different points of the country and at the same time diversified. This means that the relationship between production and consumption is complex, it is not just about consuming a product, but also about diversifying consumption. And, this diversification requires diverse strategies.

It transpires that beer production and the competitiveness of a global market could both undermine crafted beer productions, their potency and supply capacity, but simultaneously generated a demand for an increasingly diverse production.

Thus, the large breweries began to serve several countries in the world, and as a parallel phenomenon, small and medium-sized breweries also exposed large companies and society itself, its importance and wealth. And for this to be possible it was necessary to develop operating strategies, since small and medium-sized productions do not always access structures for production.

The mode of production called Gypsy Breweries, Ghosts, or Cuckoo are therefore an object of analysis, especially the gypsy production, because it is a strategy of production on a smaller scale and, using equipment and infrastructure of larger breweries.

Thus, gypsy production allows a brewer, who has neither a factory nor the means of production, to access the means of production of another producer to create his product.

In this case study, the gypsy production in Goiás state, in central Brazil, will be analyzed. It is noteworthy that Brazil is a country of competitive international production and, theoretically, an environment with great supply and brewing culture.

Therefore, it should be noted that the existing consumer environment has also become demanding and has enabled the production of smaller breweries and of gypsy beers.

Gypsy breweries were thus called from the beer production proposals alternatively by the Danes Mikkel Borg Bjergsø and Kristian Klarup Keller. These are beers produced using the structure of industrial breweries, which allow, by means of a contract, stipulating payment methods for the use of equipment, which make it possible to produce beer from being handmade or homemade to becoming commercial or industrial.

In this sense, it is necessary to reflect on the different forms of production processes that occur within the traditional production system. One can see in what way consumption has transformed allowing the co-existence of products of large companies, and the diversified ones.

II. DYNAMICS OF BEER PRODUCTION AND CONSUMPTION WORLDWIDE

The consumer society is a reality in many developed and developing countries of the world. In developing countries, or unequal countries such as Brazil, this consumer society has advanced in recent years.

As the unequal countries advance in stimulating their consumer markets, the lower classes advance in the consumption of different products, hitherto not accessible or unknown in different parts of the world.

Regarding the beverage market, the advance in consumption is no different. The market for alcoholic beverages in Brazil and in the world has grown since its birth.

The beer market is diverse, with small, medium and large productions that have spread throughout the world.

A craft beer is produced by a craft brewer. According to the Brewers Association (2018), in America, a craft brewer can be classified as:

- Small: Annual production of 6 million barrels of beer or less (approximately 3 percent of U.S. annual sales). Beer production is attributed to a brewer according to the rules of alternating proprietorships.
- Independent: Less than 25% of the craft brewery is owned or controlled (or equivalent economic interest) by a beverage alcohol industry member which is not itself a craft brewer.
- Traditional: A brewer which has most of its total beverage alcohol volume in beers whose flavors derive from traditional or innovative brewing ingredients and their fermentation. Flavored Malt Beverages (FMBs) are not considered beers.

Before the advance of capitalism to Southern countries, production was concentrated in the Northern hemisphere. Thus, until the end of the decade of 1930, the countries that produced more beer were: United States, Germany and, Great Britain.

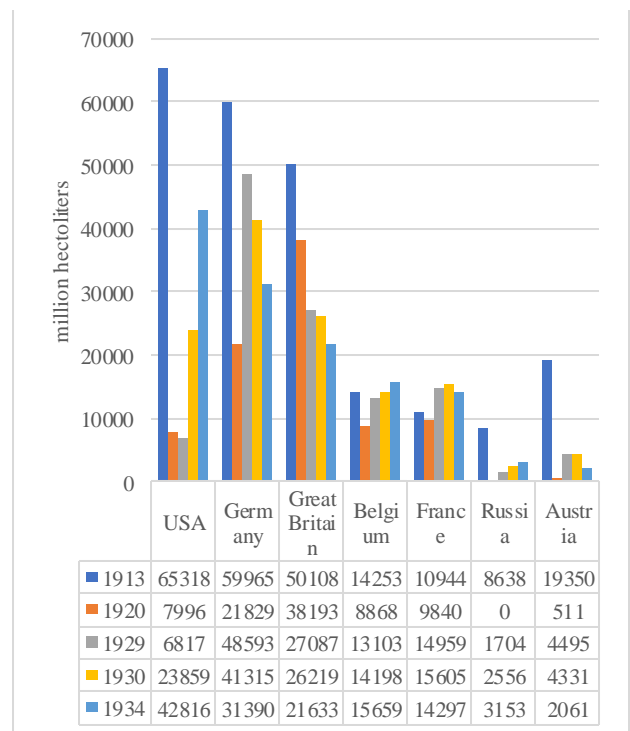


Fig.1: Main beer producing countries, 1913-1934 (selected years, in million hectoliters).

Source: Limberger (2016, p. 27)

By the 1960s, the scenario had not yet been modified. Therefore, the largest producers in the world were represented by the countries: United States, the Federal Republic of Germany (West Germany) and Great Britain.

There was loss of importance in the case of Belgium and growth in the case of Russia and Czechoslovakia.

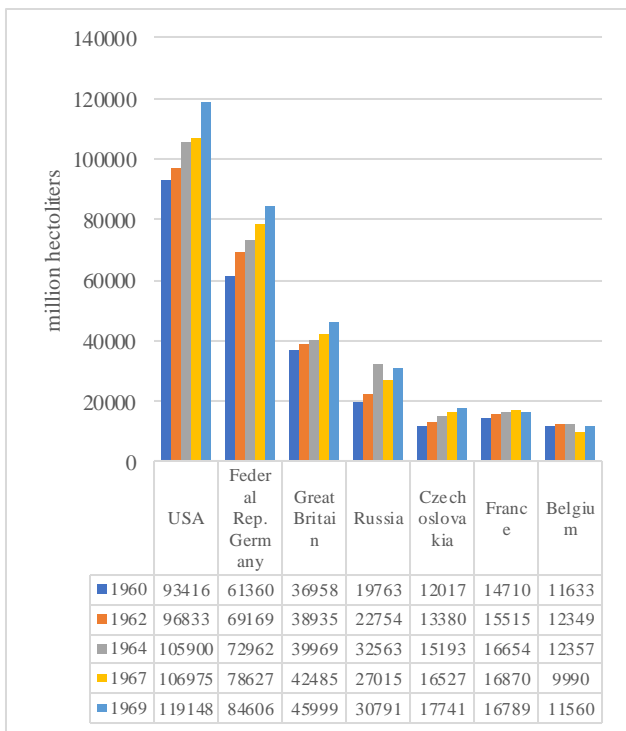


Fig.2: Main beer producing countries in the 1960s (selected years, in million hectoliters)

Source: Limberger (2016, p. 31)

After this configuration, along the expansion of brewing production in the world, countries traditionally producing beer were losing space, and, according to Limberger (2016), traditional brewing countries were losing ground to production growing in the periphery countries of the capitalist system, and the enterprises of these countries were expanding into these new emerging markets. The degree of concentration has increased, products have been globalized and competition has been faced more intensively in the world market (Limberger, 2016, p. 10).

These transformations have generated changes in global production scenarios.

Big countries in beverage production point to the sector's competitiveness worldwide. The largest breweries in the world are in countries in Europe and America, with data that draw attention to countries such as Germany, the Netherlands, the United States and, in recent years, Brazil.

Brazil stood out in the decade of 2010 by the growth of the industry and the acquisition of foreign industries, showing international competition. Producers such as Ambev and Inbev are examples of this expansion.

Table 1: Global Beer Production by Country in 2016

		2016					2015	
2016 Rank	2015 Rank	Country	Production Volume (kl)	Growth from Previous Year	Global Market Share Incremental (%)	Global Market Share Cumulative (%)	Production Volume (kl)	Growth from Previous Year
1	1	China	41,416,700	-3.7%	21.7%	21.7%	43,008,000	-4.3%
2	2	United States	22,135,300	-0.7%	11.6%	33.3%	22,286,900	-1.4%
3	3	Brazil	13,334,600	-3.8%	7.0%	40.3%	13,857,500	-2.0%
4	4	Mexico	10,500,000	8.1%	5.5%	45.8%	9,710,000	-4.5%
5	5	Germany	9,495,700	-0.7%	5.0%	50.7%	9,562,300	0.4%
6	6	Russia	7,810,000	-0.4%	4.1%	54.8%	7,841,400	2.3%
7	7	Japan*	5,352,000	-2.1%	2.8%	57.6%	5,464,300	-0.1%
8	8	United Kingdom	4,373,400	-0.9%	2.3%	59.9%	4,413,100	-0.5%
9	10	Vietnam	4,080,000	11.2%	2.1%	62.1%	3,670,000	20.1%
10	9	Poland	4,073,100	-0.4%	2.1%	64.2%	4,090,000	3.5%
11	11	Spain	3,620,000	4.1%	1.9%	66.1%	3,477,500	3.7%
12	12	South Africa	3,200,000	-0.4%	1.7%	67.8%	3,213,000	2.0%
13	13	Nigeria	2,600,000	-3.7%	1.4%	69.1%	2,700,000	0.0%
14	14	France	2,468,000	2.7%	1.3%	70.4%	2,402,000	17.3%
15	15	Netherlands	2,455,900	2.3%	1.3%	71.7%	2,401,200	1.3%
16	16	Thailand	2,403,600	2.0%	1.3%	73.0%	2,356,200	6.4%
17	17	India	2,210,000	4.2%	1.2%	74.1%	2,120,000	6.0%
18	19	Belgium	2,061,600	4.1%	1.1%	75.2%	1,981,100	8.8%
19	18	South Korea	2,000,000	-2.7%	1.0%	76.3%	2,056,300	-0.9%
20	22	Czech Republic	1,929,900	1.4%	1.0%	77.3%	1,903,300	2.4%
21	24	Colombia	1,910,000	5.5%	1.0%	78.3%	1,810,000	5.2%
22	23	Canada	1,900,000	0.1%	1.0%	79.3%	1,897,300	0.2%
23	25	Argentina	1,800,000	7.1%	0.9%	80.2%	1,680,000	1.8%
24	21	Ukraine	1,798,000	-7.6%	0.9%	81.1%	1,946,000	-19.6%
25	28	Philippines	1,650,000	5.8%	0.9%	82.0%	1,560,000	4.0%
		Global Total	190,918,700	-0.6%	100.0%	100.0%	191,991,300	-0.6%

Source: Kirin Beer University (2017)

The data that present the production by country therefore expose a geography of production by volume different from the geography of production by diversity. Thus, after the 1990s, there was a great transformation in the brewing production scenario. And in the decade of 2010, the countries that stood out in production, in volume, worldwide, were China, the United States and Brazil.

When the data are analyzed by region, Asia presents itself as the first producing region of the world, and the second region is represented by Europe, which with all countries, constitute a larger production than North America, and South America not summed.

Table 2: Global Beer Production by Region in 2016

Region	Production Volume in 2016 (kl)	633ml Bottle Equivalent (million bottles)	Growth from Previous Year	Global Market Share	Production Volume in 2015
Japan*	5,352,000	8,455	-2.1%	2.8%	5,464,300
Asia (excluding Japan)	57,802,100	91,315	-1.5%	30.3%	58,677,200
Asia Total	63,154,100	99,770	-1.5%	33.1%	64,141,500
Europe	52,097,100	82,302	0.5%	27.3%	51,830,800
North America (United States and Canada)	24,035,300	37,970	-0.6%	12.6%	24,184,200
Central and South America	34,039,300	53,775	-1.1%	17.8%	34,426,200
Africa	14,504,100	22,913	1.5%	7.6%	14,284,900
Middle East	1,059,200	1,673	-2.6%	0.6%	1,087,000
Oceania	2,029,600	3,206	-0.3%	1.1%	2,036,700
Global Total	190,918,700	301,609	-0.6%	100.0%	191,991,300

Source: Kirin Beer University (2017)

Historically, there have been major changes in beer consumption worldwide. In recent times, the per capita

consumption has decreased in traditional “beer drinking nations” while it increased strongly in emerging economies. Climatic conditions, religion, and relative prices also influence beer consumption (Colen & Swinnen, 2016).

A quantitative empirical analysis by Colen and Swinnen (2016) demonstrates that the relationship between income and beer consumption has an inverse U-shape. With rising incomes, beer consumption initially increases, but at higher levels of income it falls.

According to Stack et al. (2016, p.54), “Although beer is an ancient beverage, brewing as an industry was not historically one of the driving forces of globalization. Certainly, there are instances during the past century of specific brands being made available in other countries, but for the most part, beer brands have not crossed national borders. In many countries, beer, more than many products, has become intertwined with notions of national identity and pride. As a result, the efforts to internationalize in this market must overcome deep cultural associations regarding the product, the producer and the consumer.”

III. THE PREFERENCE FOR CRAFT BEER

The consumer worldwide is showing a growing preference for craft beer. Figures from Euromonitor International (2014) revealed annual market share gains at rates of 3%. In order to understand this shift in preference, it is fundamental to know about the brewing revolution that has been taking place on a global scale in recent years. It is an international movement with emphasis on regional and technological productive transformations. Although beer has been produced since 8000 BC, its global popularization happened after the Second World War (Oliveira & Barcelos, 2017).

From the 1950s up until the 1980s, the production and distribution of beer in countries such as the United States and the United Kingdom were planned to satisfy a uniform and growing demand; there was little room for diversification in the product. In this period, the brewing industry became highly concentrated with few high capacity global players offering a standardized and blended product worldwide (Cabras & Bamforth, 2016). This international scenario in the 1980s was the leitmotif (one of them) for the rise of micro-breweries with new possibilities of diversification translated for the consumers in terms of choice and taste.

The characteristics of the big players (generalist firms) in the beer market left peripheral space for the upsurge of small players, specialist firms (micro-breweries, brewpubs, contract brewers) that chose narrow

homogenous targets at a regional scale (Cabras & Bamforth, 2016). The increase in the number of small specialist firms came in response to the increasing dissatisfaction of consumers with bland products offered by major brewers. “These trends indicate that consumers’ tastes were becoming increasingly sophisticated and micro-brewers were better able to cater for this market” (Cabras & Higgins, 2016, p. 615).

The interest for stronger flavors was one important reason for the rise of craft beer but not the only one. Consumers were also looking over quality, accepting drinking less but drinking better (Euromonitor International, 2017). The driver for craft beer is as much linked to notions of localization, authenticity and heritage. In fact, this interest was sparked five decades ago with a pioneer initiative in the United Kingdom called Campaign for Real Ale (CAMRA), a movement of beer lovers that valued the traditional way of producing and storing beer. This was the first wave by Cabras and Bamforth (2016). The second wave happened in the early 1990s and was characterized by the entrance of new founders barely connected to breweries or brewing, such as retirees or beer-lovers looking for a career change. The third wave came in the early 2000s and was testified by a growing number of micro-breweries due to the development in brewing technologies reducing the price of equipment that became more compact and easier to install.

The brewing revolution also had its branches in Latin America, an important emerging market. According to Oliveira and Barcelos (2017) the Brazilian brewing sector experienced a market transformation as the craft beer was introduced. Superior quality drinks and new flavors were highly appreciated in contrast to light beer which is subject to massive production.

The devotion manifested by beer lovers is such that they are willing to travel to experience a good product with full-bodied characteristics. More enthusiastic beer lovers are favorably disposed to know the beers as much as to understand their production process. In this vein, brewers in Brazil adopt integrative marketing strategies, like guided visits to factories, tours in specialized beer fairs, partnerships with bars and gastronomic places (Oliveira & Barcelos, 2017).

In short, the craft beer industry came as an answer to the complaint of consumers unsatisfied with the homogenized, standardized and blended flavor products made by dominant international players. In response to the growing sophistication of the consumer in the last decades, new organizational forms of business (small specialized firms) started supplying this consumer with

differentiated and stronger flavor products, made preferably with traditional processes guaranteeing the high quality demanded.

IV. DYNAMICS OF BRAZILIAN BEER PRODUCTION AND ITS COMPETITIVENESS

Brewery production in Brazil originated, according to Limberger (2016), mainly due to the European immigration that came to Brazil in the mid-nineteenth century. Small industries were formed in the South and Southeast and were being extinguished with the industrialization and growth of big companies.

The history of this productive sector reflects, therefore, the history of the population's advances in the territory, of urbanization and Brazilian industrialization. Therefore, as the population entered the territory, the phenomenon of urbanization and industrialization spread, and the beer industry also spread.

Figure 3 points out some of the main moments of the Brazilian industrial production and its dissemination in the territory. The industrial production, as can be seen, starts in the south and southeast of Brazil, and advances to the other regions.

Thus, at the end of 1800 there were already three Brazilian breweries, founded in the states of Rio de Janeiro and São Paulo. And, from 1930, Brahma and Antarctica began to seek to distribute their production in new regions of the national territory and acquire small businesses. A national competition was started for the growth of production and distribution in Brazil.

In the 1970s, Brahma acquired companies from the states of Goiás, Ceará, Bahia and Amazonas, and Antarctica acquired companies from the states of São Paulo, Rio Grande do Sul, Amazonas, Bahia, Minas Gerais, Goiás, Espírito Santo, Piauí and Paraná.

In the 1980s, Brahma acquired companies from the state of São Paulo, Paraná, Rio Grande do Sul and Rio de Janeiro. And, Antarctica acquired companies from Rio Grande do Sul, Minas Gerais, Rio de Janeiro, Paraná, Piauí, Paraíba and Rio Grande do Norte.

Thus, in the 1970s, Antarctica already had companies in all regions of Brazil, and Brahma had not only acquired companies in the South, and in the 1980s, both companies already had production in all regions of the country.

During the twentieth century, the great national companies reached the full extent of the national territory, with Brahma becoming the fifth largest brewery in the world in the 1990s and Antarctica among the fifteen largest in the world.

The process of acquisition of small and medium-sized breweries by large breweries occurred in several countries

worldwide, not only in Brazil. The sector presents product heterogeneity, brand diversity and great competition to access consumers.

As an example of the dynamics of growth and acquisitions reference may be made to the Dutch company Heineken. This company was also founded in year 1800 and guaranteed its expansion with the acquisition of companies in countries of North America, Asia and Europe.

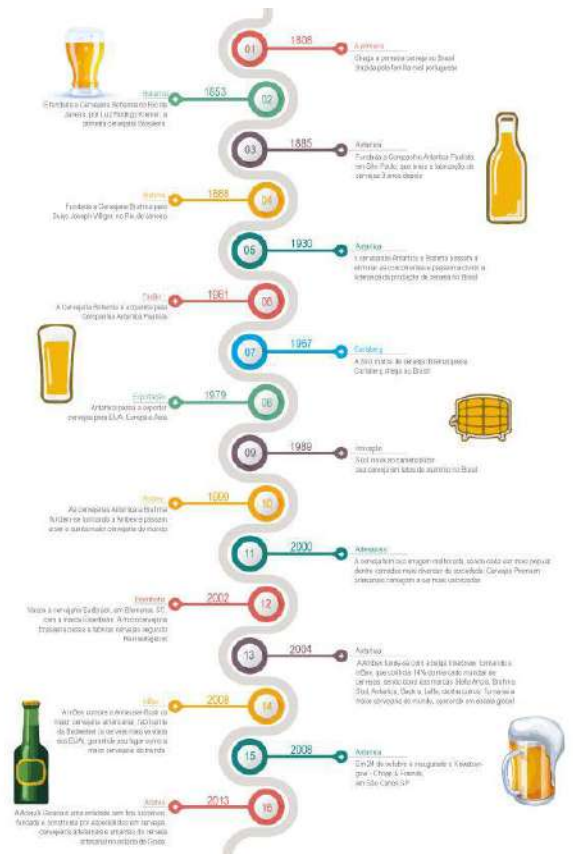


Fig.3: History of beer production in Brazil

Source: Janini (2009), <http://www.asterisko.com.br/a-saga-da-erveja/>. Organization: Lopes, G.P.

The dynamics of competition between companies, however, became global and, throughout the 2000s, according to Limberger (2016), Brazilian companies were denationalized.

Thus, the market was controlled by groups such as AB-Inbev (and its subsidiary Ambev), which dominates almost 70% of the market, Kirin Brazil, (which acquired Schincariol), Heineken Brasil (which acquired Kaiser and Bavaria), and the Brazilian brewery Petrópolis. In this sense, four companies control 95% of the Brazilian market.

Nowadays the beer industry represents 1.6% of Brazilian GDP. 14,1 billion liters are produced annually. R\$ 21 billion in taxes go to the Government. 38 thousand of vehicles in fleet are used in distribution channels. 2.7 million jobs are involved. Each R\$ 1.00 invested in the beer industry, generates R\$ 2.50 in the Brazilian economy. 1.2 million outlets spread over the country. 99% of households are supplied with beer in Brazil. R\$ 107 billion of turnover in 2017 (Cervbrasil, 2018).

Brazil has approximately 117 thousand hectares planted with cereals destined to the production of beer. There are 610 breweries registered in the year 2017, just before the economic crisis in Brazil, 91 new breweries. There are 3 big companies dominating the market in Brazil; Ambev, Heineken and the Petropolis Group, the three together hold 98.6% of the world beer market (Martins et al., 2017).

Caravaglia and Swinnen (2018) documented when the craft beer movements started in various countries, and how they have evolved. The authors also discuss the role of changes in demand, the role of pioneers in craft brewing, and what factors determined the re-emergence of small brewers. Some of the factors discussed by the authors refer to the role of information, networks, regulation, capital, and technology markets.

V. THE COMEBACK OF SMALL AND MEDIUM SIZE BREWERIES AND THE DIVERSIFICATION OF PRODUCTION

Limberger (2016) identified the geo-economic dynamics of the Brazilian brewing sector, the presence of oligopolies and the emergence of smaller companies that the author called marginal. Marginal companies were considered micro-breweries to produce high value-added beers because they made profits that did not exceed the average profit.

From the 1990s onwards, Brazil presented a highly competitive environment with oligopoly leadership, and from the 2000s onwards, an environment of great potential for consumption of higher quality products was created, the income of the Brazilian population raised, and the lack of diversification of Brazilian beer production, which marketed several brands of distinct qualities, but of similar standards, has been overcome.

According to the Brazilian Institute of Applied Economic Research, between 2001 and 2011, the per capita income of the richest 10% increased to 16.6% in accumulated terms, while the income of the poorest grew notably by 91.2% in the period (IPEA, 2012).

The growth in the consumption of the products of marginal companies, which we call small and medium-

sized enterprises, was also due to the increase in the population's income, which consisted of beers of different standards and higher prices.

Thus, from the 1990s, after a long period of growth of the national brands Brahma and Antarctica, with the acquisition of several smaller breweries, small breweries of artisanal production began to be reborn. These producers had a differentiated strategy, since they were not producing, filtering, pasteurizing and bottling for trade, but producing for sale in barrels, bars or in the factory itself (Limberger, 2016). This phenomenon of craft beer production and appreciation of this production occurred in the 1970s in countries such as the United States and the United Kingdom.

The revival of small breweries comes therefore from artisanal productions, and from socioeconomic change, from enlargement of income, from cultural change and consumption, with the expansion of the demand conditions that allowed stimuli to appreciate differentiated products.

In a very significant group of microbreweries, the initial capital invested in the creation of the company comes from other industrial businesses, being the brewing activity a way to diversify the family business. In this group, we can mention the breweries Bierland, MisturaClássica, Colorado, Burgerman, DaDo Bier and Insana (Limberger, 2016, p.125).

In her analysis of Brazilian breweries, Limberger (2016) identified the following types: craft breweries, independent breweries, commercial microbrewery of the large company, and small traditional breweries.

- Craft breweries: small-scale enterprises, which produce in small quantities, with a small contingent of labor, for limited public, are concentrated in local or regional markets, do not invest in machinery, whose entrepreneurs dominate the productive process, including purchases and sales, whose investments are oriented to the creation of new products, and, optimization of the productive process with adaptations that do not require a large capital contribution.
- Independent breweries: they are companies concerned with increasing production, dynamics in conducting market research, product differentiation and the use of technology used in production. It is a competitor of both artisanal producers and leading companies.
- Commercial microbrewery of large companies: large companies, or leading companies have brands generated by acquiring independent

breweries, most of which operate to compete with independent breweries, are therefore breweries that produce different types of breweries. Beers from leading companies, which in general produce lagers and pilsner (or pilsener) but are controlled by the leading companies. Brazilian examples: micro-breweries Baden-Baden and Eisenbahn, acquired by Kirin, and Wals and Colorado acquired by Ambev-AB Inbev.

- Traditional small breweries: these are breweries dedicated to the production of traditional beers, of low price, and compete with beer brands in the local, regional, national and even international market. In the case of the national analysis, the Industria Nacional de Bebidas (INAB), Zani from Paraná, and Malta and Conti from the interior of São Paulo were taken as examples.

In Brazil, state governments defined craft beer and craft brewers in their legislation. The main aspects are related to limit quantity and marketing strategies (Beni, 2017, pp. 68-70).

The Brazilian craft brewers are organized in the Associação Brasileira de Cerveja Artesanal (Abracerva, 2018). According to Beni (2017, p.71), craft beers are those brewed by one of these three types of breweries in Brazil:

- Brazilian microbrewery: based in Brazil, with at least 50% of Brazilian capital, producing own brands or for third parties, with a total production of no more than 1 million liters annually;
- Gypsy microbrewery: based in Brazil, with at least 50% of Brazilian capital, with own brands and production rights, without own brewing equipment, producing at third party industrial plants, with a total production of no more than 1 million liters annually;
- Brewpub: based in Brazil, with at least 50% of Brazilian capital, producing and marketing at the same place. Marketing is restricted to the brewpub.

The scenario of new breweries completely changed the access to the products and diversified the consumption of the products in the country. They started to live and produce artisan, independent, commercial breweries, small traditional breweries, bars producers, as well as gypsy productions. This diversity allowed the expansion of the consumption of other styles of the drink, which stopped being a sector-only producer of pilsner (or pilsener) and lagers and began to produce diverse other types such as ales, pale ales, witbiers, saurs and others.

In year 2010, the culture of the consumption of more diverse products spread, and the productive sector entered the different states of the country with other forms of production, and other products.

According to the Ministry of Agriculture, Livestock and Food Supply (MAPA) in Brazil, in 2017, 679 establishments were registered as breweries, and presented 8903 registered products of breweries, beers and draft beer. Figure 4 shows the growth of Brazilian breweries 2002-2017.

Gráfico 1: Total de cervejarias por ano no Brasil

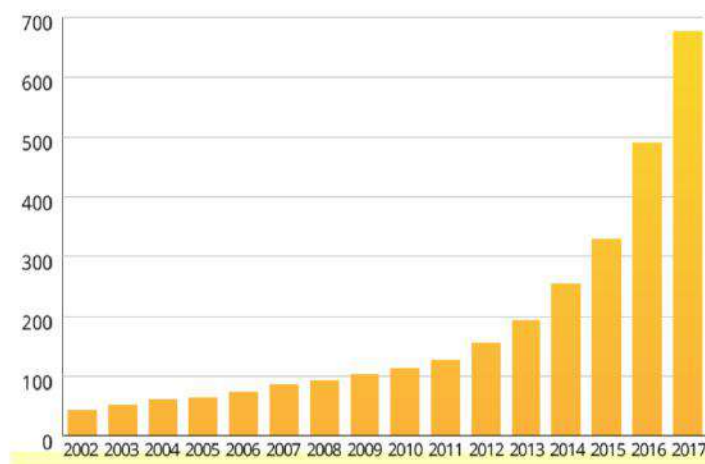


Fig.4: Number of breweries in Brazil, 2002-2017

Source: Ministério da Agricultura, Pecuária e

Abastecimento (MAPA). Available at: <http://www.agricultura.gov.br/assuntos/inspecao/produtos-vegetal/a-cerveja-no-brasil>. Accessed on Sep 2018.

Regarding the geographical distribution of breweries in Brazil, these are concentrated in the South and Southeast regions.

Table 3: Number of breweries in Brazilian states

State	Number of breweries
Rio Grande do Sul	142
São Paulo	124
Minas Gerais	87
Santa Catarina	78
Paraná	67
Rio de Janeiro	57
Goias	21
Pernambuco	17
Espirito Santo	11
Mato Grosso	11

Source: Ministério da Agricultura, Pecuária e Abastecimento (MAPA). Available at: <http://www.agricultura.gov.br/assuntos/inspecao/produtos-vegetal/a-cerveja-no-brasil>. Accessed on: September 2018.

The state of Rio Grande do Sul has the largest number of breweries, followed by the states of São Paulo and Minas Gerais, and Goiás is in the seventh position, according to the Ministry of Agriculture, Livestock and Food Supply (MAPA).

Thus, according to Carvalho et al. (2018), there is a growing market segment with different buying habits and behaviors compared to traditional beer consumers.

Craft beer emerged in Brazil during the 1990s (Krohn, 2018). With the high market concentration of bulk beer production, more and more consumers look for identity products, including beer. This creates new opportunities of interpreting competition and emerging markets.

VI. COOPETITION – COMPETING AND COOPERATING SIMULTANEOUSLY

The idea of coopetition, i.e. the simultaneous coexistence of competition and collaboration, is not new. Taking the chambers of commerce as reference, it is not difficult to understand that these institutions play an important role in the collaboration among competitors to address and solve common problems faced by the industry, such as the standardization of payment systems, lobbying on regulations, etc. One of the first chambers of commerce was found in Marseille, France, in 1599 (CCI, 2018).

The term “co-opetition” was first heard in the business context from the founder of Novell, CEO Ray Noords, in the 1980s: he argued that a company had to be able to compete and cooperate at the same time (Monticelli, 2015). In the academy the issue was introduced by Bradenburger and Nalebuff (1996); with the use of the theory of games as a support, the authors developed the dynamics of this paradoxical approach. Through collaboration, competitors can achieve better performance levels and above average profitability (Czakoń & Rogalski, 2014). As a research field, the issue is in its infancy with a limited body of literature (Ritala et al., 2016).

The firms cooperate to create value but compete for the results (Monticelli, 2015). In the coopetition relationship, agents cooperate in some activities and compete in others aiming at maximizing their gains. These relationships are based on confidence, reciprocity and altruism.

The advantages of the adoption of coopetition abound. With the game theory as reference, coopetition is a positive-sum-game (Bradenburger & Nalebuff, 1996), i.e., it is a kind of game where all the players involved can gain simultaneously. The arguments in favor of coopetition are plenty and can be listed as follows: gaining experience (Cygler & Debkowska, 2015); acquiring knowledge (Salvetat et al., 2013; Monticelli, 2015; Cygler & Debkowska, 2015); developing good business relationships (Cygler & Debkowska, 2015); increasing the size of the market, creating a new market, getting market power, augmenting the efficiency of resource utilization (Czakoń & Rogalski, 2014); accessing international opportunities (Granata et al., 2018); improving innovation capacity (Granata et al., 2018); maintaining competitiveness (Monticelli, 2015); attaining access to resources (Cygler & Debkowska, 2015; Granata et al., 2018; Hamouti, 2016; Maier, 2016; Monticelli, 2015).

There is a special interest in this paper for the access to resources and knowledge coopetition provides. A deal to concurrently collaborate and compete can be a gateway to the acquisition of complementary/supplementary resources. This way a firm can overcome technical, managerial, or infrastructural limitations. In their research, Cygler and Debkowska (2015) outlined that firms should try partnerships with competitors with a strong technological position. The authors argued there is a need for differentiation among the partners' abilities in order to permit an exchange of knowledge and capacity among them. The complementarity of resources is very important in the sense that one partner becomes able to access the other's necessary resources. This sharing facilitates the reduction of operational costs and improves the innovation capacity (Hamouti, 2016). Reporting a research in Southern Brazil, Monticelli (2015) highlighted that a great portion of the small wine producing companies could only have access to international fairs, for instance, because they were cooperating with each other in an integrative project supported by the Wine Brazilian Institute (IBRAVIN) and the Agency for Promotion of Exportation and Investments (APEX). Another example is given by Kempainen (2015) in the European payment system context, where partners compete in the provision of payment instruments and services for end-users but cooperate in building the payment infrastructure and defining relevant standards.

Although the advantages are well attested by the literature, coopetition does not happen without problems. As firms are friends and rivals at the same time, there are conflicts of logic in the cooperation/competition approach

(Ritala et al., 2016). This coexistence might produce a certain tension among the personnel involved; it is a kind of emotional ambivalence (Granata et al., 2018; Kempainen, 2015). To overcome the inherent stress cooperation might bring, employees and managers should be trained to deal and accept the contradictory situation.

VII THE GYPSY BREWERIES AS A COOPERATION STRATEGY

Sorj (2008) studied how capitalism in peripheral areas restores its socioeconomic premises and presents the non-capitalist characteristics of production, which present themselves as complementary and contradictory.

In this study, the productive structure of the coffee export chain in El Salvador was evaluated, as well as the established functional relations, where the non-capitalist appropriations are perceived at the base of the productive system, which, when traversing agents and social structures, reach export activity. They present themselves then, more deeply embedded in capitalist relations.

The author draws attention to the fact that, although more specifically in the case of El Salvador, this type of relationship can be investigated in other Latin American countries.

In the case of beer production, we can see variations in the structure of capitalism, especially considering the uses of small and medium-sized machinery.

It happens that periods of equipment vacancy do not add productivity, and therefore, the relations established between small and medium producers of traditional beers, can be changed to attend artisan producers, pointing to a different use of means of production, with actions of cooperation and sharing of the means of production that at first could be different strategies in the capitalist system.

At first, sharing the means of production with other producers could mean loss of strength and diminishing the competitiveness of that producer holding the means of production. But in a highly competitive environment, it can be a strategy of access to new knowledge through the accompaniment of the artisanal production mode, made available by sharing its space and machinery.

And, in a complementary way, the artisan producer is interested in accessing equipment that does not have capital and structure, and thus enables production, and reaches a greater scale of production even with the sharing of some information through the strategy of collaboration, cooperation and sharing. There is exchange of knowledge for access to idle equipment.

Brewing beer without having a factory for it means producing in a Gypsy, Cuckoo, or Phantom way.

In the Brazilian Midwest, the brewing sector is characterized as one of the most relevant and versatile sectors of the Brazilian economy in relation to the growth and creation of new commercial niches (Lima et al., 2017).

A study by Thomé et al. (2016) suggests that the only significant item to the consumers' luxury value perception in the dimension of financial value is the higher price of premium beers.

According to Lima et al. (2017, 655-656), among the states of the Brazilian Midwest region, Goiás state has more brewers than Mato Grosso, Mato Grosso do Sul and Distrito Federal together.

Thus, although it has been exposed that in Brazil, Rio Grande do Sul stands out, it can also be said that regionally, that is, in the Midwest, Goiás stands out in the production of artisan beers and in gypsy production.

In Goiás, it is possible to identify breweries in the different categories presented above. But in general, the small traditional breweries will be presented to introduce the profile of these breweries in Goiás and present the strategy of the Gypsy Brewery and its partnerships with this type of brewery.

Goiás state is in Central Brazil. The federal capital Brasília is located within Goiás state. Goiás state has beer production structures serving national as well as local production.

According to the Integrated System of Agricultural Products and Establishments - SIPEAGRO of the Ministry of Agriculture, Livestock and Supply, there are 29 registered breweries in the Midwest, of which 18 are concentrated in Goiás.

Of the 18 breweries registered at MAPA, 02 are large breweries, Ambev and Brasil Kirin, and the others are small and traditional breweries, responsible to produce pilsner (or pilsener) and lager beers, and there are also breweries that produce different types of beers, such as Santa Dica.

Table 4: Breweries of the Brazilian Midwest registered at the Ministry of Agriculture, Livestock and Food Supply (MAPA).

CENTRO OESTE			
ESTADO	RAZÃO SOCIAL	ATIVIDADE	DENOMINAÇÃO
DF	JINBEER CERVEJARIA ARTESANAL ME	PRODUTOR	CERVEJA
DF	MAFIABEER INDUSTRIA E COMERCIO DE BEBIDAS LTDA ME	PRODUTOR	CERVEJA
GOIÁS			
ESTADO	RAZÃO SOCIAL	ATIVIDADE	DENOMINAÇÃO
GO	AMBEV S.A.	PRODUTOR	CERVEJA
GO	BRASIL KIRIN INDUSTRIA DE BEBIDAS LTDA	PRODUTOR	CERVEJA
GO	CERVEJARIA GOIAZ LTDA - ME	PRODUTOR	CERVEJA
GO	CERVEJARIA SHERIFF LTDA - ME	PRODUTOR	CERVEJA
GO	CERVEJARIA TEMPLÁRIA LTDA ME	PRODUTOR	CERVEJA
GO	EMPRESA NACIONAL DE CERVEJAS E BEBIDAS S/A	PRODUTOR	CERVEJA
GO	KLARO - MICROCERVEJARIA LTDA - EPP	PRODUTOR	CERVEJA
GO	KLIMA INDUSTRIA E COMERCIO DE BEBIDAS LTDA	PRODUTOR	CERVEJA
GO	LUZ HUMBERTO GONÇALVES GOMES EIRELI-ME	PRODUTOR	CERVEJA
GO	MICRO CERVEJARIA LHAS EIRELI ME	PRODUTOR	CERVEJA
GO	MICROCERVEJARIA CATALÃO LTDA	PRODUTOR	CERVEJA
GO	MILTON JOCHIMS & CIA.LTDA - ME	PRODUTOR	CERVEJA
GO	NATTOS BEER MICRO CERVEJARIA LTDA - ME	PRODUTOR	CERVEJA
GO	REAL MICRO CERVEJARIA LTDA - EPP	PRODUTOR	CERVEJA
GO	SABA INDUSTRIA ALIMENTICIA LTDA-ME	PRODUTOR	CERVEJA
GO	SANTA DICA BEBIDAS LTDA ME	PRODUTOR	CERVEJA
GO	SANTA LUZIA INDUSTRIA E COMÉRCIO DE BEBIDAS LTDA	PRODUTOR	CERVEJA
GO	SERRA AZUL INDUSTRIA E COMERCIO DE BEBIDAS LTDA - ME	PRODUTOR	CERVEJA
MATO GROSSO DO SUL			
ESTADO	RAZÃO SOCIAL	ATIVIDADE	DENOMINAÇÃO
MS	CERVEJARIA MOBIEER LTDA	PRODUTOR	CERVEJA
MS	CERVEJARIA PANTANAL LTDA ME	PRODUTOR	CERVEJA
MATO GROSSO			
ESTADO	RAZÃO SOCIAL	ATIVIDADE	DENOMINAÇÃO
MT	AMBEV S.A.	PRODUTOR	CERVEJA
MT	BIONDA INDUSTRIA DE BEBIDAS LTDA ME	PRODUTOR	CERVEJA
MT	CERVEJARIA LOUVADA LTDA - ME	PRODUTOR	CERVEJA
MT	CERVEJARIA PETROPOLIS DO CENTRO OESTE LTDA.	PRODUTOR	CERVEJA
MT	DARK SIDE INDUSTRIA E COMERCIO DE BEBIDAS EIRELI	PRODUTOR	CERVEJA
MT	MICRO CERVEJARIA SERRANA LTDA	PRODUTOR	CERVEJA
MT	RODRIGO EDUARDO GUNHA ME	PRODUTOR	CERVEJA

Source: Lima (2017). Available at: <https://portalseer.ufba.br/index.php/nit/article/view/23041/23041>. Access on: September 2018.

Beer production in Goiás therefore represents part of the national scenario, with the production of traditional beers by large industries, and names, global competitors, such as Ambev and Brazil Kirin, with local industries of conventional products and with local industries of diversified products. In this way, the regional and local scenario presents itself as diverse and heterogeneous.

According to the local legislation (Goiás State Law no. 13,194/2016), a craft brewer produces a maximal amount of 5 million liters of beer annually.

In addition to the productions cited, there are Gypsy productions.

So, in Goiás, as in other parts of Brazil, there is an activity called Cervejaria Cigana (gypsy brewery). It is a collaborative activity between bottled and drafted beer producers and craft beer producers.

This action seeks to enable craft brewers to access the structures of small or medium industries to produce on a larger scale. But, at the same time, the small and medium-sized industrial companies come to know the recipes and methodologies of production of the craft brewers. For this

reason, it is a strategy of shared use of structures that benefits both craft producers and industrial producers.

There are some Gypsy Breweries in Goiás. According to interviews with artisan producers and gypsies associated with the Goiás Brewery Association, there are at least 06 Gypsy breweries in Goiás, and at least another sixteen Gypsy breweries in the Federal District that also operate in Goiás. Below the main breweries gypsies who work in Goiás:

Table 5: Gypsy breweries active in Goiás state and their state of origin

	Brewery	Label	Beer types	Municipality of origin
1	Bispo		American Pale Ale (APA) and Blond Ale	Brasília-DF
2	Corina		Double India Pale Ale (IPA), Pale Ale	Brasília-DF
3	Lola		Witbier, IPA	Goiânia-GO
4	Metanoia		Witbier	Brasília – DF
5	MJ		IPA e Pale Ale	Anápolis-GO

6	Pigmeu			
7	Russian Bear			Goiânia-GO
8	Santa Dica		IPA, Hibisco and Kolsh	Pirenópolis-GO
9	Seresta		Lager, Weis and IPA	Goiânia-GO
10	Tortuga			Taguatinga-DF
11	Vila Boa		IPA	Cidade de Goiás-GO

Source: Research results

For the present research, questionnaires were sent to all 11 artisan producers and gypsies in Goiás state to answer the questions related to the forms of production, the impact of this type of activity in stimulating the consumption of differentiated products and the main challenges of this type of production. From the 11 existing gypsy breweries, four have responded our

questionnaire. The main characteristics were shown in Table 6.

Table 6: Main responses of the representatives of gypsy breweries in Goiás state

Question	Gypsy brewery			
	LOLA	MJ	Vila Boa	Corina
Location (municipality in Goiás state)	Goiânia	Anápolis	Cidade de Goiás	
What do you consider a gypsy brewery?	The term summarizes the operation of a brewery by contract, where the industrial plant is contracted, and the contractor is the gypsy.	Brewery that does not have its own factory.	To the one that does not have own structure of factory and establishes a negotiation with another brewery that has this structure of form to produce its own beer (recipe) in this place.	Brand of beers that outsources factory operation to the industrialization of its labels.
How are contracts and forms of action signed? (Factor conditions)	There are two ways: via processing of raw material where the gypsy buys and passes to the brewery the inputs or purchase of finished product	Usually it is a standard contract.	I know only what Vila Boa Brewery signs: A production contract, which establishes values, quantity, conditions and forms of payment. That clarifies about the ownership of the recipe in question.	I know three forms of contract: Shipment of industrialization, Royalties, and Distribution.

	n of the establishment. There are different taxations and different legal figures in each mode of operation .			
How can the production and consumption of gypsy beers access regional or national markets? (Influence on Factor and Demand Conditions)	Firstly, there is a change in the taxation of gypsies (ICMS-ST double taxation in interstate operations, a statute that stands at the supreme court STF) and the emergence of new factories (more capacity)	Generally, they are microbreweries that will sell only to your region.	Through the appreciation of #drinklocal culture, the use of typical ingredients, the joining of beer with local cultural aspects and advertising and targeted advertising.	Through collaborative labels and cross-brand partnerships; structuring of a supply chain specific to the segment, through incentives to the crafted beer production with the due reduction of taxes, especially ICMS.
How can gypsy	By giving more	Facilitates the life	Gypsy production can increase the	With more innovat

production influence local consumption? (Influence on Demand Conditions)	options to the final consumer there is a worsening and warming of the market, encouraging the consumption of fresh produce and the appearance of new products. If it were not the gypsies today, we would only have four local handmade brands.	of those who do not have capital to set up a factory .	market by bringing more breweries to the medium. As the investment in the factory is very high, we would not be able to diversify into brewery, styles and labels the way we are doing.	ive products since as the cost is higher, it is necessary to add value to the product . At the same time, there is more time for research and development.
What are the gypsy breweries in Goiás ? (Related and supporting industries)	It is difficult to have an exact number because it is a market with many new companies. Some that I know of GO: Lola, Seresta, MJ, Vila Boa, Pigmeus,	MJ, Lola, Seresta , Russia n, Vila Boa.	Vila Boa Cervejaria, Seresta, Lola, MJ, Cerrado, Corina, Metanoia, RussianBeer.	Corina cerrado beer, Carolina, Metanoia, Nomoco, Umabeer, Lola, Activista, EntreQuadradas, Bracitorium

	Santa Dica. From the DF: Corina, NoMoCo, Metanoia, EntreQuardras, Tortuga, Bispo. Abracerva must have some data.			
In which companies or structures do these gypsy breweries operate? (Related and supporting industry)	Basically : KlaroMicrobrewery, Cavalo Louco, Colombina andTemp lária Cervejaria (Catalão) . But there is practically a monopoly of Klaro, since it was the one that invested the most in volume and infrastructure.	Klaro	BreweryKlaro, BreweryGoyaz (Colombina), Brewery Cavalo Louco	Klaro, Stadt, Cavalo Louco
What kind of	Crafted and independ	Crafted and indepe	Craftedandindependentbreweries.	Crafted and indepen

brewery does your gypsy brewery support? (Related and supporting industry)	endent breweries .	ndent breweries.		endent breweries.
Is there support for the logistics of distribution of gypsy beers? (Related and supporting industry)	Yes. There are autonomous professionals who provide this type of service, as well as some breweries .		No	No
What are the advantages and disadvantages of this way of acting ? (Strategies, structure	Advantages: low risk and ease of operation . Disadvantages: limiting the idle capacity of the brewery and loss of competitiveness (the final	There is usually a standard contract.	Advantages: less investment Disadvantages: higher cost, accounting insecurity, low control over the logistics of the production process and difficulty in production planning due to this, subject to constant cost change.	Disadvantage in product cost and distance of quality control. Advantage is in value of investment, lean

and rivalry)	value of the product is higher through the nature of the operation).			operation and time to invest in the brand.
What are the main challenges of artisanal and gypsy production? (Strategies, structure and rivalry)	The challenge is the change of consumer habit, because there is not much appreciation of what comes from the outside yet. On the other hand, you need to invest in technology both on the shop floor and in marketing. This applies to the entire consumer chain.	Sale and distribution.	Win the uneven dispute with the large, the high tax burden, the difficulty in accessing credit lines, and the lack of union of the segment. For gypsies, the challenge is to act together to strengthen and defend exclusive interests.	Quality of equipment, team mentality, production costs and distance from large consumer centers.
Is there cooperation between gypsy	Yes. There is an exchange of information about	No.	Yes. Although the disunity still prevails, there are cooperation in events through invitations to	Yes. Events and labels together.

brewers in Brazil? (Strategies, structure and rivalry)	the operation, processes and contacts of suppliers.		participation.	
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Source: Research results

The answers present the functioning of gypsy production, its potentialities, bottlenecks and challenges. The main elements of this survey are: the importance of supporting the diversification of production, appreciation of culture, knowledge and local and regional ingredients, the use of idle equipment and infrastructures, sharing of knowledge and possibilities for innovation in processes, contractual relations, and products, and as main bottlenecks the lack of support and strategies for distribution of products, to achieve a larger scale of production of these products, fiscal incentives and lower taxation, as criticized by the producers, are the main bottlenecks.

Regarding taxes, Zobarán (2016) argued that the inclusion of Simples Nacional, adopted in October 2016, provided support for microbreweries, but this change did not appear in the producers' arguments. It is worth noting a local movement to encourage crafted beer production, through Law 3053-17, which establishes the Policy to Encourage the Production of Crafted and Drafted Beers in the state of Goiás. This law defines the microbrewery, and the incentives and requirements to achieve benefits such as reducing the rate of 10% for the product in its first and second year of validity, and from the third year this will be set at 17% in the state.

Thus, we can see a dynamic sector with unlimited capacity for innovation with respect to products, with oligopolies and market share with other types, and sizes of production and industries, with constant innovations in products, processes, and management and, with ranges ranging from international to local.

VIII. CONCLUDING REMARKS

The present article was about the consumption of beer as a custom that came from ancient times, which allowed the dissemination of the product in different parts of the globe, made possible the creation of large industries, oligopoly, reached different countries and localities and,

at the same time shares the market space with global and local products.

The industrial and crafted forms of production have not been annulled, and forms of production have arisen that involved processes of sharing the infrastructures of large companies and crafted producers, as in the case of gypsy breweries, cuckoo or ghosts.

The practices of gypsy breweries, therefore, left Europe and gained the world, and came to materialize in Goiás, Brazil. A country that stands out in the production and consumption of beer.

Among the main positive aspects of the practice of gypsy brewing in Goiás, it was possible to perceive the stimulation of diversified consumption, the possibility of using equipment in a more efficient way, taking advantage of moments of vacancy, sharing knowledge, and stimulating improvement in the quality of production, and, among the main bottlenecks are the distribution structures of production, and, the existing taxes in Brazil.

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REFERENCES

- [1] Uncorking the past. <https://m.folha.uol.com.br/ciencia/2009/11/653651-arqueologo-recria-roteiro-das-bebidas-alcoolicas-desde-antiguidade.shtml>
- [2] Brewers Association. (2018). Institutional website. Available online at: <https://www.brewersassociation.org>. Accessed: 01 sep. 2018.
- [3] Limberger, S. C. (2016). Estudo Geoeconômico do Setor Cervejeiro no Brasil: Estruturas Oligopólicas e Empresas Marginais. (PhD Dissertation, Universidade Federal de Santa Catarina). Available online at: <https://Repositorio.Ufsc.Br/Bitstream/Handle/123456789/174684/345360.Pdf?Sequence=1&Isallowed=Y>. Accessed: 29 aug. 2018.
- [4] Kirin Beer University (2017). Kirin Beer University Report Global Beer Production by Country in 2016. Available online at: https://www.kirinholdings.co.jp/english/news/2017/0810_01.html. Accessed: 01 Sep. 2018.
- [5] Colen, L., & Swinnen, J. (2016). Economic growth, globalisation and beer consumption. *Journal of Agricultural Economics*, 67(1), 186-207.
- [6] Stack, M., Gartland, M., & Keane, T. (2016). Path dependency, behavioral lock-in and the international market for beer. In *Brewing, beer and pubs* (pp. 54-73). Palgrave Macmillan, London.
- [7] Euromonitor International. (2014). Passport. Access on Sept 22nd, 2018. Available online at <http://www.euromonitor.com/passport#/home>.
- [8] Oliveira, G.R., and Barcellos, M.D. (2017). Technology, production paradigm and operation: transformation of the Brazilian brewing sector. *Journal of Operations and Supply Chain Management*, 10(2), 44-55.
- [9] Cabras, I., and Bamforth, C. (2016). From reviving tradition to fostering innovation and changing marketing: the evolution of micro-brewing in the UK and US, 1980-2012. *Business History*, 58(5), 625-646.
- [10] Cabras, I., and Higgins, D.M. (2016). Beer, brewing and business history. *Business History*, 58(5), 609-624.
- [11] Euromonitor International. (2017). Craft Beer: Coming of Age or Past Its Prime? Access on Sept 23rd 2018. Available at <https://www.euromonitor.com/craft-beer-coming-of-age-or-past-its-prime/report>.
- [12] Cervbrasil. (2018). Dados do setor cervejeiro nacional. Available online at: http://www.cervbrasil.org.br/novo_site/dados-do-setor/. Accessed: 01 sep. 2018.
- [13] Martins, L. F., Pandolfi, M. A., & Coimbra, C. C. (2017). Análise dos indicadores do mercado cervejeiro brasileiro. V Simpósio de Tecnologia da FATEC Taquaritinga. Available online at: <http://simtec.fatectq.edu.br/index.php/simtec/article/view/261>. Accessed: 01 sep. 2018.
- [14] Garavaglia, C., & Swinnen, J. (2018). Economics of the craft beer revolution: A comparative international perspective. In *Economic Perspectives on Craft Beer* (pp. 3-51). Palgrave Macmillan, Cham.
- [15] IPEA – Instituto Brasileiro de Economia Aplicada. (2012). A Década Inclusiva (2001-2011): Desigualdade, Pobreza e Políticas de Renda. Available online at: http://www.ipea.gov.br/portal/images/stories/PDFs/comunicado/120925_comunicado155rev3_final.pdf. Accessed on: September 2018.
- [16] Beni, P. F. (2017). Inovação e estratégia: um estudo no mercado de cervejas artesanais brasileiro. (Master thesis, Universidade Presbiteriana Mackenzie).
- [17] Abracerva. (2018). Associação Brasileira de Cerveja Artesanal. Online available at: <http://abracerva.com.br>. Accessed: 01 sep. 2018.
- [18] Carvalho, N. B., Minim, L. A., Nascimento, M., Ferreira, G. H. D. C., & Minim, V. P. R. (2018). Characterization of the consumer market and motivations for the consumption of craft beer. *British Food Journal*, 120(2), 378-391.
- [19] Krohn, L. V. H. (2018). Beber, fazer, vender: formação do mercado de cerveja artesanal no Brasil. (Doctoral dissertation, Universidade de São Paulo).
- [20] Chambre de Commerce et d'Industrie – CCI (2018). Parcourir notre histoire. Les dates clés du réseau. Available at <http://www.cci.fr/web/organisation-du-reseau/histoire>. Access on Sept 20th, 2018.

- [21] Monticelli, J.M. (2015). Competição, cooperação e coopeitação: simetrias e discrepâncias na indústria vitivinícola do RS. *Revista de Administração da UNIMEP*, 13(2), 1-25.
- [22] Bradenburger, A. M., & Nalebuff, B. J. (1996). *Co-opetition*. Nova Iorque: Currency Doubleday.
- [23] Czakon, W., and Rogalski, M. (2014). Coopetition typology revisited – a behavioural approach. *Int. J. Business Environment*, 6(1), 28-46.
- [24] Ritala, P., Kraus, S., and Bouncken, R. B. (2016). Introduction to coopetition and innovation: contemporary topics and future research opportunities. *Int. J. Technology Management*, 71(1-2), 1-9.
- [25] Cygler, J., and Debkowska, K. (2015). Coopetition Effect Determinants: competitor's size, geographical scope, market and technological positions. *Organizacija*, 48(4), 219-231.
- [26] Salvetat, D., Geraudel, M., and D'Armagnac, S. (2013). Inter-organizational knowledge management in a cooperative context in the aeronautic and space industry. *Knowledge Management Research & Practice*, 11(3), 265–277.
- [27] Granata, J., Lasch, F., Le Roy, F., and Dna, L. (2018). How do micro-firms manage coopetition? A study of the wine sector in France. *International Journal of Small Business*. Ahead of printing.
- [28] Hamouti, R. (2016). Create alone or in cooperation: What is the best strategy for the performance of radical product innovation in the video game industry? The ISPIM Innovation Summit, Kuala Lumpur, Malaysia on 4-7 December 2016.
- [29] Maier, T. (2016). Sources of Microbrewery Competitiveness in the Czech Republic. *Agris on-line Papers in Economics and Informatics*. Volume VIII Number 4, 2016.
- [30] Kempainen, K. (2015). Competition-cooperation nexus in the European retail payments market: Views from a network industry perspective. *Journal of Payments Strategy & Systems*, 8(4), 386-394.
- [31] Sorj, B. (2008). Modos de produção e imperialismo: modelos alternativos. In: Sorj, B., Cardoso, FH., and Font, M., orgs. *Economia e movimentos sociais na América Latina*. Rio de Janeiro: Centro Edelstein de Pesquisa Social, pp. 65-113.
- [32] Lima, L. A., Fernandes, T. L., da Silva Tenório, L. X., da Silva, M. L., Evaristo, R. B. W., Ghesti, G. F., & Martin, A. R. (2017). Sinopse do cenário cervejeiro: O advento da produção e o mercado na região Centro-Oeste. *Cadernos de Prospecção*, 10(4), 650.
- [33] Thomé, K. M., Pinho, G. D. M., Fonseca, D. P., & Soares, A. B. P. (2016). Consumers' luxury value perception in the Brazilian premium beer market. *International Journal of Wine Business Research*, 28(4), 369-386.
- [34] Zobarán, E. (2017). Com inclusão no Simples Nacional, microcervejarias protejam transformação no setor. Available online at: <[https://blogs.oglobo.globo.com/saideira/post/com-](https://blogs.oglobo.globo.com/saideira/post/com-inclusao-no-simples-nacional-microcervejarias-projetam-transformacao-no-setor.html)

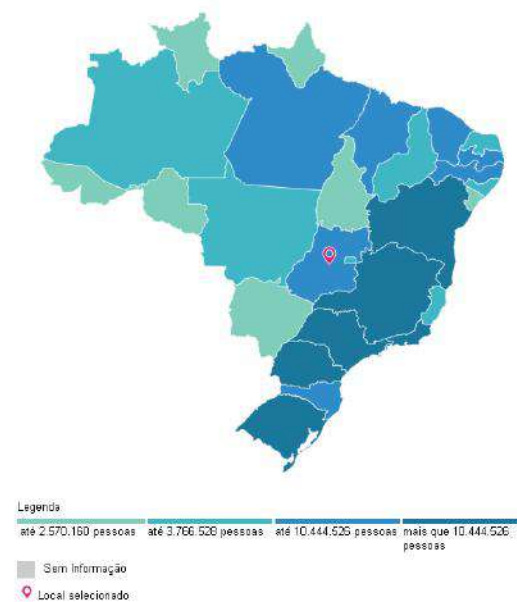
<https://blogs.oglobo.globo.com/saideira/post/com-inclusao-no-simples-nacional-microcervejarias-projetam-transformacao-no-setor.html>>. Accessed: 27 Jun. 2017.

Breweries

- [35] <https://www.otempo.com.br/blogs/ceveja-%C3%A9-Cultura-19.513013/Cervejaria-Cigana-%C3%A9-Alternativa-Para-Cervejeiros-Sem-F%C3%A1brica-19.1034588>
- [36] <http://Cervejariacapimbranco.Com.Br/Cervejaria-Cigana/>
- [37] https://Www.SympLa.Com.Br/Cervejarias-Ciganas-Desafios-E-Oportunidades__152416
- [38] <https://Www.Amazon.Com.Br/Mikkeller-Mikkell-Borg-Bjergs%C3%B8-Ebook/Dp/B00tu207m0>

IX. APPENDIX

Appendix I: Location map of Goiás state in Brazil



Source: <http://cidades.ibge.gov.br/brasil/go/panorama>

Appendix 2: Time line of growth of Brahma and Antarctica breweries

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Quadro 8 – Principais investimentos da Brahma e da Antarctica nos anos 70

Empresa	Ano	Movimento	Empresa	Localização
Brahma	1971	Aquisição	Fábrica Astra	Fortaleza/CE
	1972	Associação	Fratelli Vita	Salvador/BA
	1973	Aquisição	Cibeb	Camaçari/BA
	1973	Aquisição	Miranda Corrêa	Manaus/AM
Antarctica	1974	Aquisição	Cebrasa	Anápolis/GO
	1972	Aquisição	Cervejaria Polar	Estrela/RS
		Aquisição	Cervejaria de Manaus	Manaus/AM
		Aquisição	C. Bahiana e Alimentos Ciquine	Camaçari/BA
	1973	Fusão	Cervejaria Paulista	Ribeirão Preto/SP
		Aquisição	Cervejaria Pérola	Caxias/RS
		Aquisição	Itacolomy	Pirapó/MG
		Unidades	Fábricas	Goiana/GO, Montenegro/RS, Rio de Janeiro/RJ e Viana/ES
		Unidade	Pesquisa	Manaus/AM
	1975	Unidade	Fábricas	Teresina/PI
	1977	Ampliação	Maltaria	São Paulo
1977	Unidade	Pesquisa	Paulo de Frontim/PR	

Fonte: Portal Cervesia, 2014; Gazeta Mercantil, 1997; outras fontes. Organizado pela autora.

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Quadro 9 – Principais investimentos da Brahma e da Antarctica nos anos 80

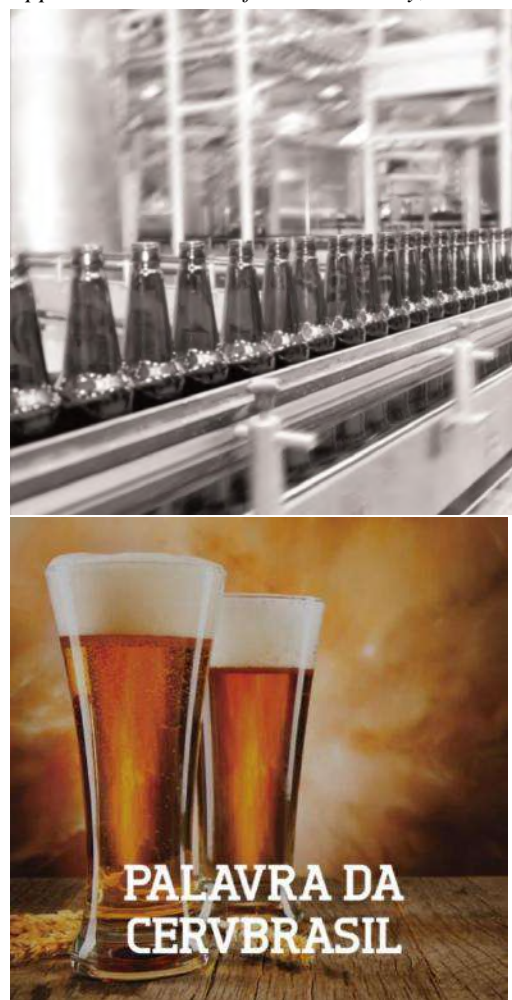
Empresa	Ano	Movimento	Empresa	Localização
Brahma	1980	Aquisição	Cervejarias Reunidas Skol/Caracu	São Paulo e Londrina/PR
	1984	Associação	Pepsico Internacional	São Paulo e Rio Grande do Sul
	1987	Unidade	Pesquisa	Rio de Janeiro
	1988/1989	Unidade	Fábrica	Jacaré/SP
Antarctica	1980	Aquisição	Cervejaria Serramate	Getúlio Vargas e Feliz/RS
		Aquisição	Cia. Alterosa de Cervejas	Vespasiano/MG
		Associação	Arosuco	Guarulhos/RJ
	1982	Unidade	Armazenagem e beneficiamento de cevada	Lapa/PR
	1983	Unidade	Fábrica	Teresina/PI
1984	Unidade	Fábrica	João Pessoa/PB	

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	1988	Unidade	Fábrica	Rio de Janeiro
	1988/1989	Unidade	Fábricas	Jaguariúna/SP, Canoas/RS, Cuiabá/MT e Rio Grande do Norte.
	1989	Aquisição	Cerpasa	São Gonçalo/RN

Fonte: Portal Cervesia, 2014; Gazeta Mercantil, 1997; outras fontes. Organizado pela autora.

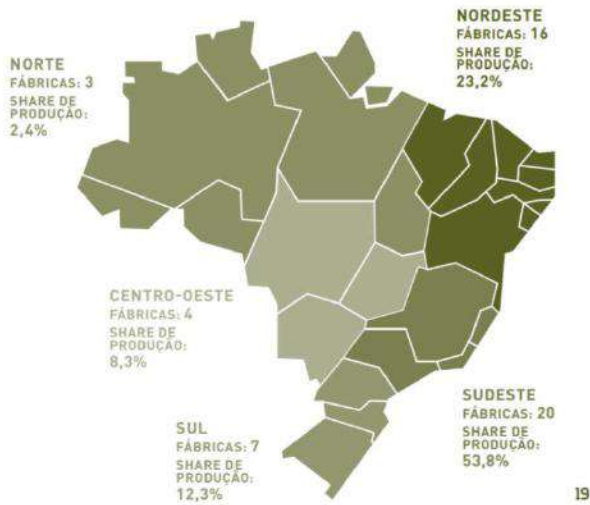
Appendix 3: Picture of Beer Directory, 2016



Source: Anuário da Cerveja, 2016, p. 12 e 13, available at: http://www.cervbrasil.org.br/novo_site/anuarios/CervBrasil-Anuario2016_WEB.pdf

Appendix 4: Map of beer production in Brazil

O setor cervejeiro investe pesado para estar sempre perto do consumidor, além de gerar empregos e desenvolvimento socioeconômico. Fábricas e centros de distribuição, estão espalhados por todo o país.



Source: Anuário do Cervejeiro, 2016, p. 19, available at: http://www.cervbrasil.org.br/novo_site/anuarios/CervBrasil-Anuario2016_WEB.pdf

Appendix 5: Beer production chain in Brazil

CERVEJEIRO



Source: Anuário da Cerveja, 2016, p. 15, available at: http://www.cervbrasil.org.br/novo_site/anuarios/CervBrasil-Anuario2016_WEB.pdf

Russian Bear	André Natal	+55 62 929 6-389 66	https://www-1.surveio.com/survey/d/B5S5E2B2D2O1T4M0A
Vila Boa	Vandré	+55 62 965 6-865 6	https://www-1.surveio.com/survey/d/V2X5C2L7U8O4B3S5H
Pigmeu	Edgar Silva	+55 64 920 3-666 2	https://www-1.surveio.com/survey/d/F4K9K9M8K2V6Y4H6D
Corina	Marcelo Branco	+55 61 841 2-468 7	https://www-1.surveio.com/survey/d/K7R7L1L3Y4B1F4P5E
NoMoCo	Gilberto		https://www-1.surveio.com/survey/d/M2S4A7Y9L9G2D9I4D
Seresta			https://www-1.surveio.com/survey/d/K0Y8D6P3O2K8E6E3W
Tortuga			https://www-1.surveio.com/survey/d/X2S4S8W7X6I0F4S1G
Metanoia			https://www-1.surveio.com/survey/d/O3H8N0F6B1L1E1A7A
Santa Dica			https://www-1.surveio.com/survey/d/O0D2G9G5R0O6J6S5F
Bispo			https://www-1.surveio.com/survey/d/N3G9O0X6B8E0A2K5D

Appendix 6: Questionnaires sent out and contacted breweries

Brewery	Contact person	Phone	Link

What do we know about Customer Satisfaction and Loyalty? A Bibliometric Analysis

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Abstract— In this study, we explored the Status Quo of the academic literature on customer satisfaction and loyalty, and its research developments. In order to do so, we performed a bibliometric analysis from 1,358,318 scientific articles extracted from the periodical CAPES, over a period of 10 years, using three research axes. As results, we indicate some insights and research paths. Within this context, one of the main contributions of this work was to carry out research with the creation of a framework, which presents the Status Quo on customer satisfaction and loyalty. Based on these results, we propose topics that can be used in agendas for future research. These themes offer the potential to advance scientific knowledge about the relationships and interrelationships between customer satisfaction and loyalty.

Keywords — Bibliometric analysis; Structure of knowledge; Conceptual evolution; Emerging trends; Consumer behavior.

I. INTRODUCTION

In today's competitive marketplace, products and services within the same industry are becoming more and more similar. Thus, in terms of market positioning, companies have sought more differentiation that can keep them close to the customer (NOYAN; ŞİMŞEK, 2014). However, due to market competitiveness, this proximity needs to be based on customer expectations, something that should also be reviewed cyclically (NYADZAYO; KHAJEHZADEH, 2016). For this reason, Pérez and Rodriguez Del Bosque (2015) stress that consumer behavior, although complex, is an important aspect that needs to be carefully analyzed by company managers to obtain competitive advantages.

For Agnihotri et al. (2016), most often customers use and pay for services on demand without worrying about perceived value, failing to consider initial costs. In the opinion of these authors, the satisfaction generated in clients that have this posture, is highly influenced by social media. This may have the occurrence of influences from multiple sources.

However, Han and Hyun (2015) and, Ahrholdt et al. (2017) agree that customer satisfaction is the product of the judgment that is constructed during the acquisition of a service or product of a particular brand or establishment. From this, according to these authors, there is a perception about meeting expectations and, if they have been met, a loyalty behavior is generated.

According to Heskett et al. (1994), customer satisfaction is related to customer loyalty, which in turn is related to profitability. This approach is supported by Hallowell (1996), who emphasizes the practical importance of this assertion by saying that loyalty

behaviors, including continuity of relationship, result from clients' beliefs that the amount of value received from an establishment is greater than that available in others.

Sirdeshmukh et al. (2002) emphasize that satisfaction and loyalty, besides being intrinsically interconnected, can be represented by different dimensions and variables. For these authors, these dimensions and variables involve a tripartite view of reliability assessments along operational competence, operational benevolence perceived at the time of the relationship with the company, and dimensions of guidance for problem solving.

The objective of this work was to explore the scientific production on the subject of customer satisfaction and customer loyalty from a multivariate data analysis approach and, as a result, a portfolio of dimensions and variables that can guide researchers and, assist the performance of managers in planning and actions in the area.

The approaches carried out in this work resemble in part the work of Albanez et al. (2014), and Fetscherin and Heinrich (2015), regarding the methodological approach used. However, Albanez et al. (2014) limited their research universe to a specific periodical and also to the research period from 2007 to 2012. In relation to these authors, another important limitator is in the scope, which analyzed papers presented at scientific events organized in Brazil by the National Association of Postgraduate and Research in Administration (ANPAD). Both studies properly investigate customer satisfaction and loyalty; however, they are limited in scope because of sample selection. While Albanez et al. (2014) limited their study

to publications conducted by ANPAD, Fetscherin and Heinrich (2015) collected data only in the Web of Science database. This work was not limited in scope, since the data were collected on a large scale, without restricting them to any database, although there is a delimitation of the research universe. In addition, the studies of Albanez et al. (2014), and Fetscherin and Heinrich (2015) were performed in the beginning and mid-2000, emphasizing the need for a recent study.

II. CUSTOMER SATISFACTION

Commercial relations always start and have some outcome with clients (ASCARZA et al., 2017). For this reason, an understanding of how to effectively manage customer relationships has become an important topic for academics and practitioners in recent years (KELLER, 1993; Payne, FROW, 2005; RAHIMI et al., 2017). From the positioning in front of the competition and the market, through all the improvements of planning, actions and management of the organization interdepend of the clients (PARK et al., 2018). This interdependence leads companies to a need to meet the expectations that lead to the satisfaction of their demand and also of potential clients (ISTANBULLUOGLU, 2017).

For Shin and Managi (2017), customer satisfaction can be measured from the degree of perception of exceeding expectations and also from how the needs were met and delivered. In the view of Pansari and Kumar (2017), the current business market is highly competitive and having the satisfied customer is an important indicator of performance aligned with the urges of demand and business strategies.

According to Gao and Lai (2015), the experiences in terms of commercial relations experienced by the customer, form the satisfaction. However, these authors also point out that when customer satisfaction is measured, the literature only considers satisfaction, dimensions and variables based on specific satisfaction or, specific to the commercial transaction; with no agreement as to the best way to measure it.

For Olsen and Johnson (2003), perceived equity is a psychological reaction of the customer to the value that a service company offers. These authors also point out that, this equity fosters customer satisfaction, which can be described as cumulative satisfaction, from business relationships. It is also highlighted that, from this, clients tend to rely on all their experience, forming intentions and repurchase decisions. This view is corroborated by Ashraf et al. (2018), which define customer satisfaction as one of the main objectives of organizations. According to these authors, satisfaction leads customers to be loyal, and this can be a source of competitive advantage for the organization.

For organizations to position themselves adequately in the face of market and demand, in order to obtain sustainable competitive advantage, it is necessary to provide and improve customer satisfaction (PORTER, 2011). Due to this positioning, Aktepe et al. (2015), advocate the need to constantly carry out an analysis of customer satisfaction and, from this, review plans and actions. According to these authors, this analysis should be used as a parameter to measure levels of customer satisfaction. And, as a result of this action, take actions contrary to the points of low satisfaction detected and, also, improving the points of high satisfaction.

Pan (2015) presents another point of view that satisfaction can be measured by feedback from customers on the quality and evaluation of the products or services themselves or products. For this author, customer satisfaction is an element that can be considered erratic, this is justified because a product or service satisfies a customer and necessarily may not satisfy another. Therefore, according to Ashraf et al. (2018), in order to increase customer satisfaction, it is necessary that the dimensions and variables that influence customer satisfaction are correctly understood.

The search for an effective management of the elements that generate satisfaction and, the improvement of customer loyalty, has been approached by professionals and by the literature (ZEITHAML et al., 1993; RUST, CHUNG, 2006; BLUT et al., 2015). Several studies have found that the higher level of customer satisfaction leads to greater fidelity and, therefore, word of mouth recommendations (BODET, 2008; DENG et al., 2010; OREL; KARA, 2014; MEESALA; PAUL, 2018). The expansion of competition in the marketing of products and services has led companies to reflect on differentiating strategies that foster loyalty and, from this, attract and retain customers (OPREANA, VINERAN, 2015). However, Kumar et al. (2013) emphasize the existence of an intrinsic association between customer satisfaction and loyalty, which is highly variable and also dependent on dimensions and variables that compose the most varied scenarios. According to these authors, this association still influences the type of sector involved and the segment of clients, which, therefore, influence the nature of the variables.

III. LOYALTY OF CUSTOMERS

It can be well accepted today that competitiveness in terms of quantity and quality makes it extremely difficult for a company to differentiate itself from its competitors (NGO; NGUYEN, 2016). This, according to Alotaibi (2015), can be measured through customer loyalty, which is both an attitudinal and behavioral tendency that favors the choice of one brand over all others. For Ngo and

Nguyen (2016), for reasons of cost reduction and profit improvement, in order to build sustainable competitiveness, maintaining long-term customer loyalty is a mandatory task of organizations.

In this paper, we present the results of a study of customer loyalty (DICK, BASU, 1994; ZEITHAMLETAL et al., 1993; REICHHELD, 2003). However, Nyadzayo and Khajehzadeh (2016) emphasize that while managers take a continuous approach and emphasize planning and action that drives customer loyalty, this approach remains one of the most challenging issues facing modern day-to-day business, due to the intense breadth and market competition.

Machado (2015) emphasizes that if the customer buys the same brand regularly, it is possible to consider him a loyal customer to this brand. This author further expands this view by pointing out that a constant repurchase of the same brand may be termed trademark behavioral loyalty. This behavioral issue, according to Ngo and Nguyen (2016), occurs when a customer considers that the product or service provided by an organization remains the most appropriate alternative among so many others available in the market. According to these authors, the behavioral loyalty to brands is the one that best meets the needs, expectations and values of this client.

Customer loyalty encourages consumers to buy more consistently, and also more cyclically, by spending a larger portion of money and thus having a positive feeling about shopping experiences, helping to attract other consumers (KASIRI et al. al., 2017; LIU; ATUAHENE-GIMA, 2018). Due to this feeling, customer loyalty as the main consequence of customer satisfaction, has several ways of being defined and measured (Wright et al., 2017, Gong, YI, 2018). According to Khuong and Dai (2016), if a company invests resources to increase customer loyalty without focusing on profitability, such long-term action can lead to failures in its sustainability vis-à-vis the market.

Although customer loyalty is often related to the predisposition of shopping repeatedly (ALOTAIBI, 2015;

NGO; NGUYEN, 2016), according to Ismail and Yunan (2016), a good or service to ensure customer loyalty, needs to be accompanied by some psychological bond, and the organization must simultaneously maintain attitudes favorable to an ongoing relationship.

For Chuah et al. (2016), organizations need to establish cycles of change and manage customer satisfaction in order to retain them strategically. However, according to these authors, although these cycles may be effective in generating customer loyalty, however, they are not a suitable instrument for changing dissatisfactions when they occur.

Customer loyalty over time has been studied intensively, and has sought to identify and understand dimensions and variables that lead a consumer to become loyal, as well as the factors that make him break a loyalty relationship with a particular brand or consequences of these situations (VISENTINI, FENNER, 2017).

IV. DEVELOPMENT OF THE METHODOLOGICAL APPROACH AND RESULTS

This article was structured as a result of the investigation of the scientific production related to customer satisfaction and loyalty, with the subsequent analysis of quantitative data on works present in the literature, which were allocated in research axes to observe interfaces in these works.

Within this context, bibliometrics, which is a mechanism for reviewing scientific production, can be considered as systematic, comprehensible and reproducible, allowing a broader understanding of scientific and technological information (FETSCHERIN; HEINRICH, 2015). For this reason, and considering the assumptions presented in this section, the methodological approach of this work employed three stages (Structuring the research framework, Study for research portfolio composition and Bibliometric analysis of the research portfolio) to investigate scientific production related to satisfaction and customer loyalty (Figure 1).

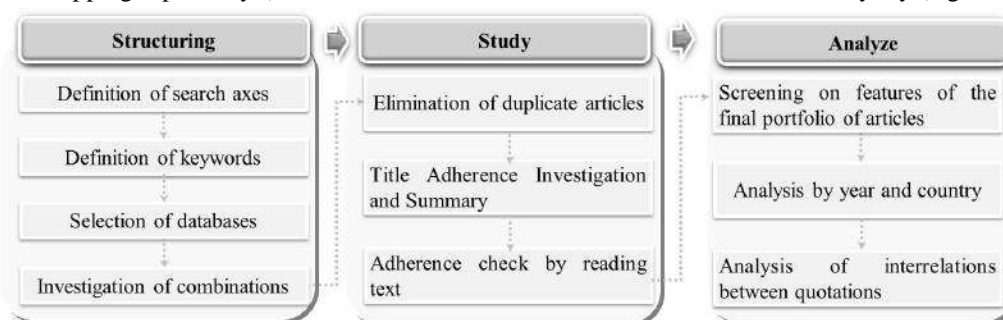


Fig. 1: Synthesis of the methodological approach used

The structuring of the research framework was started from the definition of research axes. In this work three

central axes were defined to investigate the literature. Thus, the first research axis was defined from the

Table.2: Compilation of initial search results

R ₁	Research axes (R _n)			Data base		
	R ₂	R ₃		Springer	Sciencedirect	Emerald
Multivariate data analysis	Customer expectations	Performance		28	179	65
		Customization		5	29	2
		Quality		26	197	69
		Marketing		23	145	50
		Profitability		7	66	28
Multivariate data analysis	Consumer satisfaction	Performance		10	171	33
		Customization		4	28	3
		Quality		12	234	35
		Marketing		11	194	29
		Profitability		5	58	16
Multivariate data analysis	Consumer loyalty	Performance		3	92	14
		Customization		1	17	1
		Quality		3	125	15
		Marketing		3	131	14
		Profitability		3	37	8
Total				144	1703	382

The next step in the composition of the research portfolio was to carry out a sorting of duplicate articles, which was carried out using Zotero software. In this way, all articles found (Table 2) were imported into the software operation platform, with a repetition of 1685

articles identified. Subsequently, these articles were deleted from the research portfolio, leaving a quantitative of 544 articles.

Table.3: Selected articles from the title and abstract

Author(s)	Title	Citations
Talib et al. (2013)	An empirical investigation of relationship between total quality management practices and quality performance in Indian service companies.	153
Jiewanto et al. (2012)	Influence of Service Quality, University Image, and Student Satisfaction toward WOM Intention: A Case Study on Universitas Pelita Harapan Surabaya.	82
Herrmann et al. (2006)	An empirical study of quality function deployment on company performance	49
Ramseook-Munhurrun et al. (2015)	Examining the Structural Relationships of Destination Image, Perceived Value, Tourist Satisfaction and Loyalty: Case of Mauritius.	89
Wang e Tseng (2011)	Evaluation of International Student Satisfaction using Fuzzy Importance-Performance Analysis	26
Ferreira et al. (2010)	Efeitos da responsabilidade social corporativa na intenção de compra e no benefício percebido pelo consumidor: um estudo experimental	18
Noor e Foo (2014)	Determinants of Customer Satisfaction of Service Quality: City Bus Service in Kota Kinabalu, Malaysia.	29
Abdullah (2013)	Fuzzy multi criteria decision making and its applications: A brief review of category.	35
Gil et al. (2010)	Las asociaciones de la imagen como determinantes de la satisfacción en el sector bancario español.	18
Fuentes-Blasco et al. (2014)	Effect of customer heterogeneity on the relationship satisfaction-loyalty.	26
Gregorio e Cronemyr (2011)	From expectations and needs of service customers to control chart specification limits.	17
Camgoz-Akdag e Zaim (2012).	Education: a comparative structural equation modeling study.	13
Šályová et al. (2015)	Effect of Marketing Orientation on Business Performance: A Study from Slovak Foodstuff Industry.	19
Radomir e Nistor (2012)	High-Educated Consumer Perceptions of Service Quality: An Assessment of the SSTQUAL Scale in the Romanian Banking Industry.	14

Thus, after filtering and deleting duplicate articles, a check of the adherence to the topic customer satisfaction and loyalty was performed in all 544 articles, by means of title and abstract reading. This verification allowed us to locate 507 articles that were not aligned with the topic, which were removed from the scope of the study. Proceeding, as suggested by Hicks et al. (2015), a verification of the scientific recognition of the remaining

articles was carried out. And, in this way, the other 37 publications were analyzed for scientific recognition. The purpose of this analysis was to select the most relevant literature, with two cut-off stages, the first one based on the pre-established value of 85%, that is, articles whose quotations represent 85% of the sum of all quotes in the portfolio, were selected and, below that margin, were removed from the analysis process. The second cut phase,

according to Hicks (2015), considered as included in the methodological approach, articles that were cited 12 times or more, being withdrawn to those below this level (Table 3). In order to aid in the operationalization of these searches and citation checks, the Google Scholar search tool was used.

However, as Fetscherin and Heinrich (2015) point out, a bibliometric analysis must be able to indicate the real paths that the academy has been following. For this reason, a new verification of adherence of the selected articles to the subject of customer satisfaction and loyalty was carried out, and a full reading of contents was carried out. From this, 9 articles were excluded from the framework of Table 3, due to the absence of adherence. Thus, after the previous studies, where 2229 literatures were considered, the final portfolio of articles adhering to the theme studied was obtained (Table 4).

Table.4: Composition of the final portfolio

Author(s)	Citations
Jiewanto et al. (2012)	82
Ramseook-Munhurrun et al. (2015)	89
Wang e Tseng (2011)	26
Abdullah (2013)	35
Camgoz-Akdag e Zaim (2012).	13

Sequentially, the bibliometric analysis was started, considering all the articles that compose the final portfolio and their respective citations (250 articles). This analysis followed the precepts of Hicks et al. (2015), which suggest as parameters of the literature, the year of publication, the country of origin, and the interrelations between the literatures of a field of study. Thus, from the analysis of the 250 articles, 45 different countries were identified, 9 temporal periods of publications between 2010-2018 (Figure 3), and several interrelations between literatures.

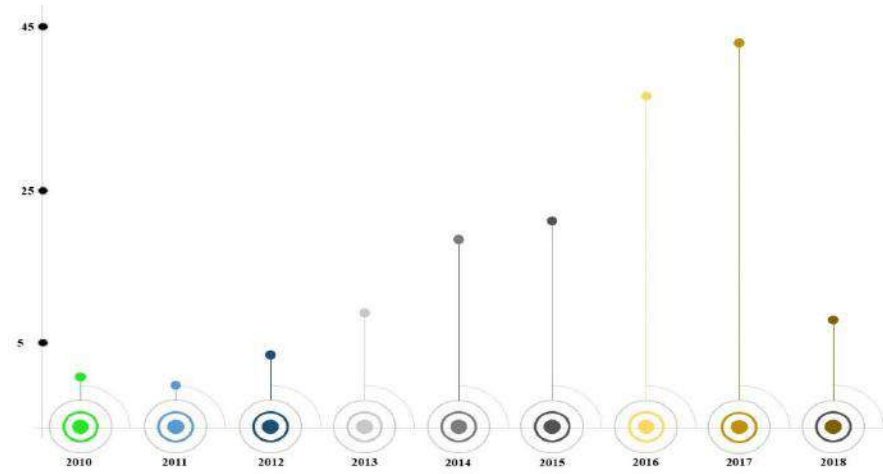


Fig. 3: Time Synthesis of Publication Behavior

Figure 3 shows the evolution of the number of articles published per year. The year with the most articles published is 2017, with forty-four articles; followed by 2016 with forty-one; 2015 with twenty-three; 2014 with twenty; 2018 with fourteen; 2013 with ten; 2012 with five of us; 2011 with an article published in the scientific journals indexed in the three databases researched. The annual average of the scientific production on the subject is 19.5 articles / year, fact that indicates the relevance and discussions in the literature. With this, it is evaluated that the scientific production on satisfaction and customer loyalty is still moderate and, it needs more researchers interested in the subject.

Figure 3 shows the evolution of the number of articles published per year. The year with the most articles published is 2017, with forty-four articles; followed by 2016 with forty-one; 2015 with twenty-three; 2014 with twenty; 2018 with fourteen; 2013 with ten; 2012 with five of us; 2011 with an article published in the scientific

journals indexed in the three databases researched. The annual average of the scientific production on the subject is 19.5 articles / year, fact that indicates the relevance and discussions in the literature. With this, there is an indication that scientific output on customer satisfaction and loyalty is still moderate. However, in ascertaining the results that Figure 3 presents, it is possible to notice that in the period comprising the years 2010 and 2011, the publications were scarce, however, after that period an increasing pattern of publications is also denoted.

Thus, as of 2011, this evolution on investigations regarding the subject of customer satisfaction and loyalty, suggests a recognition of the importance of knowing the needs and expectations of the clients with greater rigor. This can be verified through the cumulative regression of the publication behavior (Figure 4), where the obtained value of R^2 (0.96092) suggests that the adjustment of the model can explain the observed values and that the statistical conditions are adequate to confirm that the

number of publications can lead to a growing on the subject customer satisfaction and loyalty.

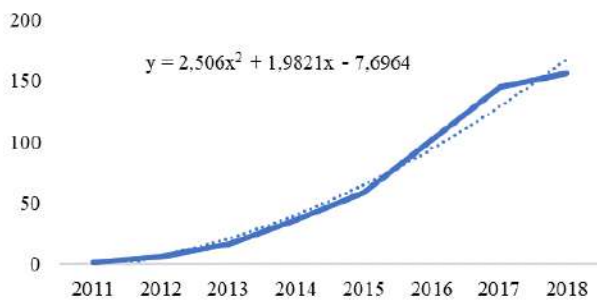


Fig. 4: Trend analysis of publications

In addition, Figure 5 shows the countries of origin of the published articles on customer satisfaction and loyalty, which were almost identified from the research axes (Table 2).

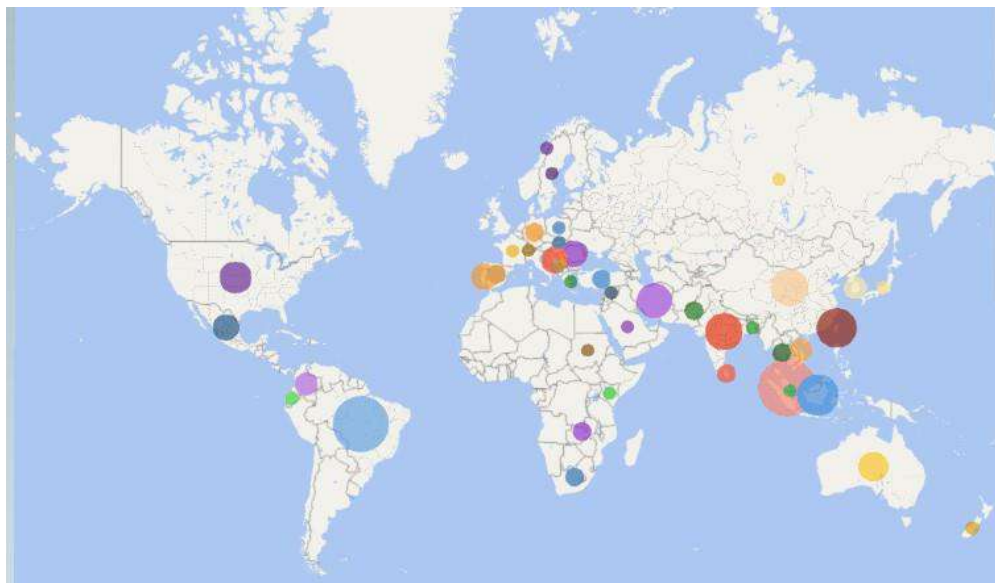


Fig. 5: Academic productivity by country

We identified 154 publications, with an average of 3 articles per country. Three countries (Brazil, Indonesia and Malaysia) contributed with 30.5% of the publications. The other countries, including South Africa, Germany, Australia, Mexico and England, for example, published on average two scientific papers each in the period analyzed. It is also noted that there are countries considered to be emerging, or in development, are publishing studies on the subject, such as Singapore, South Korea, India, Thailand and Indonesia. Although the number of publications has increased by approximately

48% since 2007, which suggests an awakening by customer satisfaction and loyalty studies, compared to other areas of knowledge, however, efforts are needed to increase and research related to customer satisfaction and loyalty.

The investigation of the interrelation between citations was made through the analysis of social networks (Figure 6), which made it possible to graphically visualize interactions among the selected literatures (Table 4), making it possible to note occurrences of relations, as well as their amplitudes.

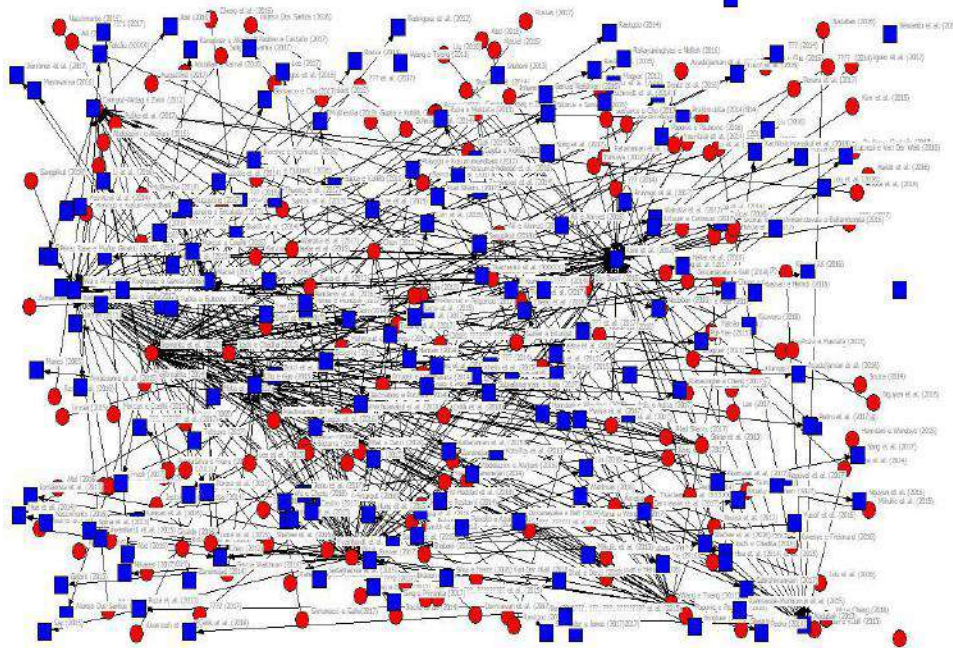


Fig. 6: Cluster structure of the citation network

The results show that, although the macroenvironment is characterized by several links, there is insufficient evidence to support the existence of a specific type of pattern or differentiate. Thus, these results also give rise to the existence that the analyzed literature has a wide influence among them. However, to broaden the reflections on the understanding of this existence, a polarization of components of social networks was made (Figure 7).

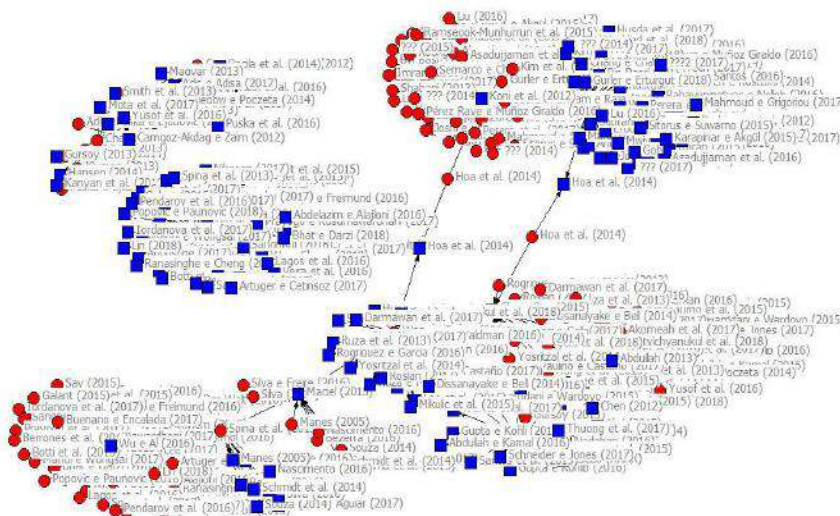


Fig. 7: Polarized cluster structure of the citation network

When the polarization of the network of citations was realized (Figure 7), isolated environments were revealed in comparison to the initial cluster. And, from this revelation, it was also possible to verify that the connections between these environments are tenuous,

suggesting the existence of little interrelation between the citations of the themes contained in the literatures of the final portfolio. From these links were identified the seven literatures that aided this polarization (Table 5).

Table.5: Synthesis of the literature used to support the polarization of the network of citations

Author(s)	Method, technique and /or tools	Application
Abdullah (2013)	<i>Fuzzy logic and Multicriteria method</i>	Decision making about consumer purchasing positioning.
Chen (2012)	<i>Fuzzy logic and Structural Equation Modeling</i>	Analysis of the repurchase rate to maximize services.
Ramseook-Munhurrun et al. (2015)	<i>Structural Equation Modeling</i>	Appreciation of constructs that influence the satisfaction and loyalty of tourists.
Jiewanto et al. (2012)	<i>Structural Equation Modeling</i>	Verification of the influence of quality parameters on the university service offer.
Wang e Tseng (2011)	<i>Fuzzy Importance-Performance Analysis</i>	Examine the dynamics that attract foreign students to higher education.
Cangoz-Akdag e Zaim (2012)	<i>Structural Equation Modeling</i>	To verify satisfaction based on the identification of variables that determine perceived quality.
Spina et al. (2013)	<i>Survey and Quality tool</i>	Evaluation of the relationship between quality and customer satisfaction.

Customer satisfaction and loyalty are areas that are complex enough to include multiple variables, which are and are, most of the time, interrelated and mutually dependent. For this reason, the efforts of the scientific community so far have been directed to the investigation and identification of these variables, as well as the relationships between them and their influence on and for the client.

V. FINAL CONSIDERATIONS

The bibliometric analysis of customer satisfaction and loyalty in this work examined the evolution of scientific production over a 10-year period, based on academic publication observations. From our analysis, we conclude that literature reviews on client satisfaction and loyalty are limited to the presentation of some context. The increase in the number of publications that has as its starting point contexts related to customer satisfaction and loyalty, suggests the interest and relevance of this work and, from this, the indication of existing gaps in the literature. Therefore, some insights and research paths are indicated. For example, a positive growth trend has been observed since 2007 and the number of publications has reached 45 in 2017. A plausible explanation for this trend can be supported by the recession and in the period of economic slowdown that businesses and enterprises faced.

However, the investigations showed that client satisfaction and loyalty is moderately exploited in the scientific environment, reflecting perspectives that present multidimensional quantitative approaches. Thus, this context may still have an investigative continuity, in which evidence tends to emerge and, from them ramifications in several areas of research, which perpass topics related to customer satisfaction and loyalty.

It is therefore not surprising that the number of high-impact publications, and thus the journals dealing with

this subject, is still small. However, the results of our inquiries shed light on a relatively new area of research, however, fascinating about the interrelationships existing between clients and dimensions and variables that influence the feeling of satisfaction and loyalty.

One of the main contributions of this work was the realization of research with subsequent creation of a framework, which presents the status quo and the indications of paths of literature on the researched topic, drawn from comprehensive literature review. These findings may be used for further research on the subject and other related topics of interest to the academy.

Other important findings are related to the most common methods applied and the data sources employed. Thus, analyzing the final literature portfolio, the most frequent search methods were multivariate data analysis and quantitative data collection, these methods were based on semi-structured interviews and surveys using closed questionnaires.

The research limitations of this work are related to the focus of publications and databases present in the CAPES Newspapers platform. Thus, it is suggested for future researches: (i) the replication to other contexts from annals of congresses, theses, dissertations and books; (ii) the expansion of bibliometric analysis through the use of other databases of scientific publications and, consequently, the identification of scientific research gaps.

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REFERENCES

- [1] Abdullah, L. Fuzzy multi criteria decision making and its applications: A brief review of category. (2013). *Procedia-Social and Behavioral Sciences*, 97, 131-136.
- [2] Agnihotri, R., Dingus, R., Hu, M. Y. and Krush, M. T. (2016). Social media: Influencing customer satisfaction in B2B sales. *Industrial Marketing Management*, 53, 172-180.
- [3] Ahrholdt, D. C., Gudergan, S. P. and Ringle, C. M. (2017). Enhancing service loyalty: The roles of delight, satisfaction, and service quality. *Journal of Travel Research*, 56(4), 436-450.
- [4] Aktepe, A., Ersöz, S. and Toklu, B. (2015). Customer satisfaction and loyalty analysis with classification algorithms and Structural Equation Modeling. *Computers & Industrial Engineering*, 86, 95-106.
- [5] Albanez, J. A. P. A., Garcia, S. F. A. G. and Galli, L. C. L. A. (2014). Métodos de pesquisa e satisfação de clientes: um estudo bibliométrico. *Brazilian Journal of Marketing, Opinion, and Media Research*, 16, 1-27.
- [6] Ali, F., Kim, W. G., Li, J., and Jeon, H. M. (2018). Make it delightful: Customers' experience, satisfaction and loyalty in Malaysian theme parks. *Journal of destination marketing & management*, 7, 1-11.
- [7] Alotaibi, M. M. (2015). Evaluation of "AIRQUAL" scale for measuring airline service quality and its effect on customer satisfaction and loyalty. 210f. Thesis (Doctorate in Transportation Management) - School of Aerospace, Transport and Manufacturing, Cranfield University, Cranfield, England.
- [8] Anderson, E. W., Fornell, C. and Lehmann, D. R. (1994). Customer satisfaction, market share, and profitability: Findings from Sweden. *Journal of marketing*, 58(3), 53-66.
- [9] Ascarza, E., Ebbes, P., Netzer, O. and Danielson, M. (2017). Beyond the target customer: Social effects of customer relationship management campaigns. *Journal of Marketing Research*, 54(3), 347-363.
- [10] Ashraf, S., Ilyas, R., Imtiaz, M. and Ahmad, S. (2018). Impact of Service Quality, Corporate Image and Perceived Value on Brand Loyalty with Presence and Absence of Customer Satisfaction: A Study of four Service Sectors of Pakistan. *International Journal of Academic Research in Business and Social Sciences*, 8(2), 452-474.
- [11] Baker, D. A. and Crompton, J. L. (2000). Quality, satisfaction and behavioral intentions. *Annals of tourism research*, 27(3), 785-804.
- [12] Blut, M., Frennea, C. M., Mittal, V. and Mothersbaugh, D. L. (2015). How procedural, financial and relational switching costs affect customer satisfaction, repurchase intentions, and repurchase behavior: a meta-analysis. *International Journal of Research in Marketing*, 32(2), 226-229.
- [13] Bodet, G. (2008). Customer satisfaction and loyalty in service: Two concepts, four constructs, several relationships. *Journal of retailing and consumer services*, 15(3), 156-162.
- [14] Bolton, R. N. and Drew, J. H. (1991). A multistage model of customers' assessments of service quality and value. *Journal of consumer research*, 17(4), 375-384.
- [15] Camgoz-Akdag, H. and Zaim, S. (2012). Education: a comparative structural equation modeling study. *Procedia-Social and Behavioral Sciences*, 47, 874-880.
- [16] Carman, J. M. (1990). Consumer perceptions of service quality: an assessment of the SERVQUAL dimensions. *Journal of retailing*, 66(6), 33-55.
- [17] Chen, S. C. (2012). Fuzzy cognitive map for optimizing solutions for retaining full-service restaurant customer. *Procedia-Social and Behavioral Sciences*, 57, 47-52.
- [18] Chuah, S. H. W., Marimuthu, M., and Ramayah, T. (2016). The Contribution of Perceived Firm Marketing Innovation Initiatives to Customer Perceived Value and Loyalty: Does Switching Experience Really Matter? *Asian Academy of Management Journal*, 21(1), 1-23.
- [19] Cronin Jr., J. J. and Taylor, S. A. (1994). SERVPERF versus SERVQUAL: reconciling performance-based and perceptions-minus-expectations measurement of service quality. *Journal of marketing*, 58(1), 125-131.
- [20] Delgado-Ballester, E. and Munuera-Alemán, J. L. Brand trust in the context of consumer loyalty. *European Journal of marketing*, 35(11/12), 1238-1258.
- [21] Deng, Z., Lu, Y., Wei, K. K. and Zhang, J. (2010). Understanding customer satisfaction and loyalty: An empirical study of mobile instant messages in China. *International journal of information management*, 30(4), 289-300.
- [22] Diaz-Martin, A. M., Iglesias, V., Vazquez, R. and Ruiz, A. V. (2000). The use of quality expectations to segment a service market. *Journal of Services Marketing*, 14(2), 132-146.
- [23] Dick, A. S. and Basu, K. (1994). Customer loyalty: toward an integrated conceptual framework. *Journal of the academy of marketing science*, 22(2), 99-113.
- [24] Ferreira, D. A., Ávila, M. and Faria, M. D. (2010). Efeitos da responsabilidade social corporativa na intenção de compra e no benefício percebido pelo consumidor: um estudo experimental. *Revista de Administração*, 45(3), 285-296.
- [25] Fetscherin, M. and Heinrich, D. (2015). Consumer brand relationships research: A bibliometric citation meta-analysis. *Journal of Business Research*, 68(2), 380-390.
- [26] Fuentes-Blasco, M., Moliner-Velázquez, B. and Gil-Saura, I. (2014). Effect of customer heterogeneity on the relationship satisfaction-loyalty. *Revista Española de Investigación de Marketing ESIC*, 18(2), 78-92.
- [27] Gao, B. W. and Lai, I. K. W. (2015). The effects of transaction-specific satisfactions and integrated satisfaction on customer loyalty. *International journal of hospitality management*, 44, 38-47.
- [28] Giese, J. L. and Cote, J. A. (2000). Defining consumer satisfaction. *Academy of marketing science review*, 1(1), 1-22.
- [29] Gil, R. B., Vallejo, J. M. and Pérez, J. M. P. (2010). Las asociaciones de la imagen como determinantes de la satisfacción en el sector bancario español. *Cuadernos de Economía y Dirección de la Empresa*, 13(43), 9-35.
- [30] Gilbert, D. and Wong, R. K. C. (2003). Passenger expectations and airline services: a Hong Kong based study. *Tourism Management*, 24(5), 519-532.

- [31] Gong, T. and Yi, Y. (2018). The effect of service quality on customer satisfaction, loyalty, and happiness in five Asian countries. *Psychology & Marketing*, 35(6), 427-442.
- [32] Gregorio, R. and Cronemyr, P. (2011). From expectations and needs of service customers to control chart specification limits. *The TQM Journal*, 23(2), 164-178.
- [33] Hallowell, R. (1996). The relationships of customer satisfaction, customer loyalty, and profitability: an empirical study. *International journal of service industry management*, 7(4), 27-42.
- [34] Han, H. and Hyun, S. S. (2015). Customer retention in the medical tourism industry: Impact of quality, satisfaction, trust, and price reasonableness. *Tourism Management*, 46, 20-29.
- [35] Hellier, P. K., Geursen, G. M., Carr, R. A. and Rickard, J. A. (2003). Customer repurchase intention: A general structural equation model. *European journal of marketing*, 37(11/12), 1762-1800.
- [36] Herrmann, A., Huber, F., Algesheime, R. and Tomczak, T. (2006). An empirical study of quality function deployment on company performance. *International Journal of Quality & Reliability Management*, 23(4), 345-366.
- [37] Heskett, J. L., Jones, T. O., Loveman, G. W., Sasser, W. E. and Schlesinger, L. A. (1994). Putting the service-profit chain to work. *Harvard business review*, 72(2), 164-174.
- [38] Hicks, D., Wouters, P., Waltman, L., Rijcke, S. and Rafols, I. (2015). Bibliometrics: the Leiden Manifesto for research metrics. *Nature News*, 520(7548), 429-431.
- [39] Hur, W. M., Moon, T. W. and Jung, Y. S. (2015). Customer response to employee emotional labor: the structural relationship between emotional labor, job satisfaction, and customer satisfaction. *Journal of Services Marketing*, 29(1), 71-80.
- [40] Iacobucci, D., Ostrom, A. and Grayson, K. (1995). Distinguishing service quality and customer satisfaction: the voice of the consumer. *Journal of consumer psychology*, 4(3), 277-303.
- [41] Ismail, A. and Yunan, Y. M. (2016). Service quality as a predictor of customer satisfaction and customer loyalty. *LogForum*, 12(4), 269-283.
- [42] Istanbuluoglu, D. (2017). Complaint handling on social media: The impact of multiple response times on consumer satisfaction. *Computers in Human Behavior*, 74, 72-82.
- [43] Jiewanto, A., Laurens, C. and Nelloh, L. (2012). Influence of service quality, university image, and student satisfaction toward WOM intention: A case study on Universitas Pelita Harapan Surabaya. *Procedia-Social and Behavioral Sciences*, 40, 16-23.
- [44] Keller, K. L. (1993). Measuring, and Managing Customer-Based Brand Equity. *Journal of Marketing*, 57(1), 1-22.
- [45] Kelley, S. W. and Davis, M. A. (1994). Antecedents to customer expectations for service recovery. *Journal of the Academy of Marketing Science*, 22(1), 52-61.
- [46] Khuong, M. N. and Dai, N. Q. (2016). The Factors Affecting Customer Satisfaction and Customer Loyalty - A Study of Local Taxi Companies in Ho Chi Minh City, Vietnam. *International Journal of Innovation, Management and Technology*, 7(5), 228-233.
- [47] Kumar, V., Dalla Pozza, I. and Ganesh, J. (2013). Revisiting the satisfaction-loyalty relationship: empirical generalizations and directions for future research. *Journal of Retailing*, 89(3), 246-262.
- [48] Liu, W. and Atuahene-Gima, K. (2018). Enhancing product innovation performance in a dysfunctional competitive environment: The roles of competitive strategies and market-based assets. *Industrial Marketing Management*, 73, 7-20.
- [49] Machado, R. W. R. (2015). A relação entre confiança, satisfação e lealdade: estudo de mercado de seguros. 99f. *Dissertation (Master in Business Administration) - Faculty of Business Sciences, FUMEC University, Belo Horizonte, Brasil.*
- [50] Mackay, K. J. and Crompton, J. L. (1988). A conceptual model of consumer evaluation of recreation service quality. *Leisure Studies*, 7(1), 40-49.
- [51] Mckinney, V., Yoon, K. and Zahedi, F. M. (2002). The measurement of web-customer satisfaction: An expectation and disconfirmation approach. *Information systems research*, 13(3), 296-315.
- [52] Meesala, A. and Paul, J. (2018). Service quality, consumer satisfaction and loyalty in hospitals: Thinking for the future. *Journal of Retailing and Consumer Services*, 40, 261-269.
- [53] Ngo, V. M. and Nguyen, H. H. (2016). The relationship between service quality, customer satisfaction and customer loyalty: An investigation in Vietnamese retail banking sector. *Journal of Competitiveness*, 8(2), 103-116.
- [54] Noor, H. M. and Foo, J. (2014). Determinants of customer satisfaction of service quality: City bus service in Kota Kinabalu, Malaysia. *Procedia-Social and Behavioral Sciences*, 153, 595-605.
- [55] Noyan, F. and Şimşek, G. G. (2014). The antecedents of customer loyalty. *Procedia-Social and Behavioral Sciences*, 109, 1220-1224.
- [56] Nyadzayo, M. W. and Khajehzadeh, S. (2016). The antecedents of customer loyalty: A moderated mediation model of customer relationship management quality and brand image. *Journal of Retailing and Consumer Services*, 30, p. 262-270.
- [57] OLIVER, R. L. (1999). Whence consumer loyalty? *Journal of marketing*, 63(4), 33-44.
- [58] Olsen, L. L. and Johnson, M. D. (2003). Service equity, satisfaction, and loyalty: from transaction-specific to cumulative evaluations. *Journal of Service Research*, 5(3), 184-195.
- [59] Opreana, A. and Vinerean, S. (2015). A new development in online marketing: Introducing digital inbound marketing. *Expert Journal of Marketing*, 3(1), 29-34.
- [60] Orel, F. D. and Kara, A. (2014). Supermarket self-checkout service quality, customer satisfaction, and loyalty: Empirical evidence from an emerging market. *Journal of Retailing and Consumer Services*, 21(2), 118-129.
- [61] Ostrom, A. and Iacobucci, D. (1995). Consumer trade-offs and the evaluation of services. *Journal of marketing*, 59(1), 17-28.
- [62] Pan, F. C. (2015). Practical application of importance-performance analysis in determining critical job

- satisfaction factors of a tourist hotel. *Tourism Management*, 46, 84-91.
- [63] Pansari, A. and Kumar, V. (2017). Customer engagement: the construct, antecedents, and consequences. *Journal of the Academy of Marketing Science*, 45(3), 294-311.
- [64] Parasuraman, A., Berry, L. L. and ZEITHAML, V. A. (1991). Understanding customer expectations of service. *Sloan management review*, 32(3), 39-48.
- [65] _____. (1994). Reassessment of expectations as a comparison standard in measuring service quality: implications for further research. *Journal of marketing*, 58(1), 111-124.
- [66] Park, S., Hahn, S., Lee, T. and Jun, M. (2018). Two factor model of consumer satisfaction: International tourism research. *Tourism Management*, 67, 82-88.
- [67] Payne, A. and Frow, P. (2005). A strategic framework for customer relationship management. *Journal of marketing*, 69(4), 167-176.
- [68] Pérez, A. and Rodriguez Del Bosque, I. (2015). Corporate social responsibility and customer loyalty: exploring the role of identification, satisfaction and type of company. *Journal of Services Marketing*, 29(1), 15-25.
- [69] Pleger Bebko, C. (2000). Service intangibility and its impact on consumer expectations of service quality. *Journal of Services Marketing*, 14(1), 9-26.
- [70] Porter, M. E. (2011). *Competitive advantage of nations: creating and sustaining superior performance*. 2nd. New York: Simon and Schuster.
- [71] Radomir, L. and Nistor, C. V. (2012). High-educated consumer perceptions of service quality: an assessment of the SSTQUAL scale in the Romanian banking industry. *Procedia Economics and Finance*, 3, 858-864.
- [72] Rahimi, R., Köseoglu, M. A., Ersoy, A. B. and Okumus, F. (2017). Customer relationship management research in tourism and hospitality: a state-of-the-art. *Tourism Review*, 72(2), 209-220.
- [73] Ramseook-Munhurrin, P., Seebaluck, V. N. and Naidoo, P. (2015). Examining the structural relationships of destination image, perceived value, tourist satisfaction and loyalty: case of Mauritius. *Procedia-Social and Behavioral Sciences*, 175, 252-259.
- [74] Reichheld, F. F. (2003). The one number you need to grow. *Harvard business review*, 81(12), 46-55.
- [75] Rust, R. T. and Chung, T. S. (2006). Marketing models of service and relationships. *Marketing Science*, 25(6), 560-580.
- [76] Šályová, S., Tábořecká-Petrovičová, J., Nedelová, G. and Ďaďo, J. (2015). Effect of marketing orientation on business performance: A study from Slovak foodstuff industry. *Procedia Economics and Finance*, 34, 622-629.
- [77] Shin, K. J. and Managi, S. (2017). Liberalization of a retail electricity market: Consumer satisfaction and household switching behavior in Japan. *Energy Policy*, 110, 675-685.
- [78] Sirdeshmukh, D., Singh, J. and Sabol, B. (2002). Consumer trust, value, and loyalty in relational exchanges. *Journal of marketing*, 66(1), 15-37.
- [79] Spina, D. T., Giraldi, J. M. E. and Oliveira, M. M. B. (2013). A influência das dimensões da qualidade de serviços na satisfação do cliente: um estudo em uma empresa do setor de controle de pragas. *REGGE Revista de Gestão*, 20(1), 93-112.
- [80] Swartz, T. A. and brown, S. W. (1989). Consumer and provider expectations and experiences in evaluating professional service quality. *Journal of the Academy of Marketing Science*, 17(2), 189-195.
- [81] Talib, F., Rahman, Z. and Qureshi, M. N. (2013). An empirical investigation of relationship between total quality management practices and quality performance in Indian service companies. *International journal of quality & reliability management*, 30(3), 280-318.
- [82] Teas, R. K. (1993). Expectations, performance evaluation, and consumers' perceptions of quality. *Journal of marketing*, 57(4), 18-34.
- [83] Tse, D. K. and Wilton, P. C. (1988). Models of consumer satisfaction formation: An extension. *Journal of marketing research*, 25(2), 204-212.
- [84] Van Riel, A. C. R., Liljander, V. and Jurriens, P. (2001). Exploring consumer evaluations of e-services: a portal site. *International journal of service industry management*, 12(4), 359-377.
- [85] Visentini, M. S. and Fenner, V. U. (2017). Lealdade: análise da produção científica brasileira na área de marketing no período compreendido entre 2010 e 2016. *Perspectivas em Gestão & Conhecimento*, 7(2), 175-198.
- [86] Wang, R. and Tseng, M. (2011). Evaluation of international student satisfaction using fuzzy importance-performance analysis. *Procedia-Social and Behavioral Sciences*, 25, 438-446.
- [87] Westbrook, R. A. and Oliver, R. L. (1991). The dimensionality of consumption emotion patterns and consumer satisfaction. *Journal of consumer research*, 18(1), 84-91.
- [88] Wolter, J. S., Bock, D., Smith, J. S. and Cronin Jr., J. J. (2017). Creating ultimate customer loyalty through loyalty conviction and customer-company identification. *Journal of Retailing*, 93(4), 458-476.
- [89] Yi, Y. (1990). A critical review of consumer satisfaction. *Review of marketing*, 4(1), 68-123.
- [90] _____. (1993). The determinants of consumer satisfaction: the moderating role of ambiguity. *ACR North American Advances*.
- [91] Yu, Y. T. and Dean, A. (2001). The contribution of emotional satisfaction to consumer loyalty. *International journal of service industry management*, 12(3), 234-250.
- [92] Zeithaml, V. A., Berry, L. L. and Parasuraman, A. (1993). The nature and determinants of customer expectations of service. *Journal of the academy of Marketing Science*, 21(1), 1-12.
- [93] _____. (1996). The behavioural consequences of service quality. *Journal of Marketing*, 60(2), 31-46.

Relationship between obstructive sleep Apnea Syndrome and Anthropometric Measures

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Abstract— Anthropometric measures characterized by body mass index and waist and neck circumferences, are considered strong predictors of sleep disorders. Thus, the objective of this research was to evaluate the relationship between anthropometric data and sleep disorder in adults and elderly individuals. The research was carried out with patients attending at a Cardiology Clinic in a city in the interior of the center-west of São Paulo. In addition to personal identification data, anthropometric measures of weight, height, waist (CC) and neck circumferences (NC) and body mass index (BMI) were calculated. The occurrence of sleep disturbance was assessed under the aspect of the risk of occurrence of obstructive sleep apnea (OSA) using the STOP-Bang questionnaire. The study was approved by the Research Ethics Committee of the University of Marília - Unimar. Adult and elderly patients (n=197) participated in the study, 47% of them male. The mean age of participants was 59.52 ± 13.41 years. With regard to the risk of OSA, 50% of the participants presented intermediate risk, whereas 22% and 28% were classified as low and high risk, respectively, and such risk was significantly related to the anthropometric measures. The Mean Confidence Interval (95%) indicated that BMI, CC and NC values greater than 26.3 kg / m², 90.4 cm and 26.3 cm, respectively, carry a risk of OSA. In conclusion, in view of the results found, more research is needed to improve the understanding of the determinants of sleep disorders in order to prevent or improve the diagnosis and treatment of these conditions.

Keywords— Anthropometry. Sleep apnea. STOP-Bang questionnaire.

I. INTRODUCTION

Modern societies have achieved more benefits and comfort for everyday life, but these advantages have led to profound modifications in the way of life. The consequence was a rapid transition between the effort to search for food (and consequent energy expenditure) by the purchase of industrialized products that generally contain high levels of sugar and fat. Allied to this, there was also a reduction in the practice of physical activity, facts that led to the increase of overweight and obesity worldwide (BARBALHO et al., 2015; SADEGUI et al., 2016; BEMMOHAMMED et al., 2016).

These lifestyle changes have an impact on the incidence of metabolic disorders such as the development of type 2 diabetes, dyslipidemias, systemic arterial hypertension (HAS), and metabolic syndrome (MS) that aggravate the risk of developing cardiovascular disease (CVD), which are the most common chronic-degenerative diseases related to mortality (SALTIEL et al., 2017;

CALABUIG et al., 2016; ZAHID et al., 2016; FURUHASHI et al., 2015)

Anthropometric measures that mark overweight (overweight or obese), including body mass index and waist and neck circumferences, are considered to be strongly related to the occurrence of sleep disorders (CARTER and WATTENPAUGH, 2008). Sleep is one of the natural functions of the living being controlled by the biological clock. The occurrence of sleep disorders plays a significant role in the aetiology of diseases associated with MS, such as obesity, diabetes and hypertension (SPIEGEL et al., 2004). In addition, studies have shown that poor sleep quality, especially in combination with increased visceral adiposity, is strongly linked to the development of a chronic, low-intensity inflammatory state leading to the release of cytokines and chemokines, including interleukin-1 beta (IL-1 β), tumor necrosis factor alpha (TNF- α) and IL-6, as well as hs-CRP and cortisol, factors that contribute to the aggravation of numerous metabolic complications (HUANG et al., 2017;

PRATHER et al., 2014; LIU et al., 2014; OPP, 2005; PRINZ et al., 2000).

These findings led to the objective of this research to evaluate the relationship between anthropometric data and sleep disorder in adults and elderly individuals.

II. METHODS

This is an exploratory, analytical, primary and observational, cross-sectional, single center study. The research was carried out with patients attending a Cardiology Clinic in a city in the interior of the center-west of São Paulo.

Patients were invited to participate in the study receiving clarification on the research protocol and those who accepted confirmed the acceptance by signing the informed consent form.

In addition to the personal identification data (name, sex and age), information was collected on the level of schooling, previous diagnosis of diseases or clinical conditions, use of medication on a continuous basis, presence of smoking, consumption of alcoholic beverages and practice of physical activity.

The anthropometric measurements were weight and height, from which the body mass index (BMI) was calculated. The waist (WC) and neck circumferences (NC) were also collected. For the collection of weight, stature and WC we used techniques recommended by Lohman et al. (1988) and Gibson (2005). The BMI was calculated according to Quetelet's formula (COLE et al., 1981). NC was measured at the mean neck height and in men just below the laryngeal prominence (BEN-NOUN; LAOR, 2003). NC was classified according to Ben-Noun et al. (2001), which values less than 34 cm and 37 cm are considered in normality for women and men, respectively.

The occurrence of sleep disturbance was assessed in terms of the risk of occurrence of obstructive

sleep apnea (OSA) using the STOP-Bang (Snoring, Tiredness, Observed Apnea, and High Blood Pressure - Body mass index, Age, Neck Circumference, and Gender) consisting of eight issues relating to snoring, fatigue / fatigue / drowsiness, and apnea observed during sleep, blood pressure, BMI, age, NC, and gender. Questions can be answered affirmatively by a point or negatively by zero point, and the final score of this instrument can range from zero to 8 points. Summation between zero and two points indicates low risk of OSA, while three to four points indicates intermediate risk and five to eight points high risk (FONSECA et al., 2016).

The statistical treatment of the quantitative data was performed with the support of the BioEstat 5.0 program. The data were presented by means of relative frequency and the descriptive statistics in table presenting the mean \pm standard deviation, median and minimum and maximum values. In order to evaluate the significance of the relationship between the studied variables, Student's t-tests, Anova followed by Tukey, Kruskal-Wallis followed by Dunn, and Pearson's correlation tests and the mean confidence interval (Bootstrap Resampling Technique) were used. The tests were selected according to the purpose of the analysis and the variance of the data to be analyzed. The probability of significance considered was 5% ($p \leq 0.05$) for the operations performed.

This study was approved by the Research Ethics Committee of the University of Marília - Unimar under protocol number 1,989,745.

III. RESULTS AND DISCUSSION

A total of 197 adult and elderly patients were included in this study, 47% of them male. The mean age of participants was 59.52 ± 13.41 years, with no significant difference between the two sexes ($p = 0.4329$).

The anthropometric measures evaluated are presented in Table 1.

Table.1: Descriptive presentation of age and anthropometric measures evaluated.

Parameters	Mean \pm standard deviation	Median	Minimum	Maximum
Age (years)	59.52 \pm 13.41	61	25	89
BMI (kg/m ²)	28.85 \pm 5.58	28	18	58
WC (cm)	100.15 \pm 14.3	100	59	139
NC (cm)	38.32 \pm 4.24	38	29	52

BMI: body mass index. WC: waist circumference. NC: circumference of the neck.

The application of the STOP-Bang questionnaire resulted in an average score of 3.63 ± 1.56 (minimum-maximum = 0-8). With regard to OSA risk, 50% of the participants presented intermediate risk, while 22% and 28% were classified as low and high risk, respectively.

A significant relationship was found between the risk of OSA and the anthropometric measures analyzed in this study. The higher the BMI, WC and CP, the higher the risk (Table 2).

Table.2: Anthropometric measures (BMI, WC and NC) according to the risk of obstructive sleep apnea (OSA).

Risk of OAS	Measure	BMI (kg/m ²)	WC (cm)	NC (cm)
Low (n=44)	Mean±standard deviation	27.45±3.88 ^A	93.61±10.91 ^A	36.45±3.91 ^A
	CI of the mean (95%)	26.3 - 28.4	90.4 - 96.3	35.3 - 37.4
Intermediary (n=99)	Mean±standard deviation	28.20±5.42 ^A	98.09±13.12 ^A	37.78±3.61 ^A
	CI of the mean (95%)	27.2 - 29.1	95.5 - 100.2	37.1 - 38.4
High (n=54)	Mean±standard deviation	31.20±6.37 ^B	109.25±14.62 ^B	40.85±4.47 ^B
	CI of the mean (95%)	29.6 - 32.6	105.5 - 112.5	39.6 - 41.8
	p-value	0.0037*	0.0000**	0.0000**

CI: Confidence interval. BMI: body mass index. WC: waist circumference. NC: circumference of the neck. ns: non significant. *Kruskal-Wallis / Dunn. **Anova one way / Tykey. Means followed by the same capital letter in the columns do not differ from each other by the statistical test at 5% probability.

The Confidence Interval (CI) of Mean (95%) allows us to infer that BMI values above 26.3 kg / m² entail risk, at different levels, of OSA. The same reasoning is possible for WC and NC measurements, whose risk-related values are 90.4 cm and 35.3 cm, respectively.

In our study, 50% of the patients presented intermediate risk and 28% high risk of OSA. These values are superior to those found in other studies using the same instrument, the STOP-Bang.

Bamgbade et al. (2017) in a study with women undergoing abdominal surgery showed 18.1% and 11.3% had intermediate and high risk of OSA, respectively.

Dixon et al. (2016) evaluated 1635 patients from a surgical hospital and found that 14.89% had intermediate risk of OSA and only 3.93% were at high risk.

Patients from a hospital in Nigeria were evaluated by Ozoh et al. (2014). These authors found that the risk of OSA was 36.3% of patients at high risk.

Obesity was positively associated with the risk of OSA in our study as well as in others, such as that of Ozoh et al. (2014), from Bamgdage et al. (2017), from Dixon et al. (2016), de Ruiz et al. (2016) and Kielbasa et al. (2016).

Dixon et al. (2016), Bamgdage et al. (2017) observaram que a CP aumentada (> 40 cm) leva a maior risco de AOS. Ruiz et al. (2016) observaram correlação positiva entre CP e risco de AOS.

Dobrosielski et al. (2016) and Soler et al. (2017), as well as in this study, found that the higher the CP measure, the greater the risk of OSA.

The occurrence of OSA is a common condition among patients treated at the aforementioned Cardiology Clinic, with percentages higher than that of other

populations. Although the instrument used to assess such a disorder is widely known, its performance may vary among populations.

IV. CONCLUSION

The IMC, WC and NC are anthropometric measures that presented a positive and significant relationship with the occurrence of sleep disorders, since the increase of these measures led to an increased risk of OSA.

We suggest that further research is necessary to improve the understanding of the determinants of sleep disorders in order to provide prevention or even improve the diagnosis and treatment of these conditions.

REFERENCES

- [1] BAMGBADE, O.A. et al. Obstructive sleep apnea and postoperative complications among patients undergoing gynecologic oncology surgery. *Int J Gynaecol Obstet.*, v. 138, n. 1, p. 69-73, 2017.
- [2] BARBALHO, S.M. et al. Metabolic Syndrome, Atherosclerosis and inflammation: inseparable triad? *J Vasc Bras.*, v.14, n.4, p.319-326, 2015.
- [3] BENMOHAMMED, K. et al. Metabolic syndrome in adolescents: definition based on regression of IDF adult cut-off points. *Public Health.*, v.141, p 88-94, 2016.
- [4] BEN-NOUN, L.; LAOR, A. Relationship of neck circumference to cardiovascular risk factors. *Obes Res.*, v.11, p.226-31, 2003.
- [5] CALABUIG, Á. et al. Epicardial Adipose Tissue in the General Middle-aged Population and Its Association With Metabolic Syndrome. *Rev Esp Cardiol (Engl Ed)*, nov. 2016.
- [6] CARTER, R.; WATENPAUGH, D.E. Obesity and obstructive sleep apnea: or is it OSA and obesity? *Pathophysiology*, v. 15, n. 2, p.71-7, 2008.

- [7] COLE, T.J.; DONNET, M.L.; STANFIELD, J.P. Weight-for-height indices to assess nutritional status - a new index on a slide-rule. *Am J Clin Nutr.*, v.34, n.9, p.1935- 1943, Sep., 1981.
- [8] DIXON, S.E. et al. Quality Improvement Project: Using the STOP-BANG Tool in a Military Population to Improve Equity in Preoperative Screening. *J Perianesth Nurs.*, v. 31, n. 5, p. 371-80, 2016.
- [9] DOBROSIELSKI, D.A. et al. Estimating the Prevalence of Sleep-Disordered Breathing Among Collegiate Football Players. *Respir Care.*, v. 61, n. 9, p. 1144-50. 2016.
- [10] FONSECA, L.B.M. et al. STOP-Bang questionnaire: translation to Portuguese and cross-cultural adaptation for use in Brazil. *J Bras Pneumol.*, v.42, n.4, p.266-72, 2016.
- [11] FURUHASHI, M. et al. Fatty acid binding protein 4 (FABP4): Pathophysiological insights and potent clinical biomarker of metabolic and cardiovascular diseases. *Clin Med Insights Cardiol.*, v. 8 (Suppl 3), p.23-33, 2015.
- [12] GIBSON, R.S. Principles of nutritional assessment. 2^o Edition, Oxford University Press, 2005.
- [13] HUANG W.Y. et al. Associations of Self-Reported Sleep Quality with Circulating Interferon Gamma-Inducible Protein 10, Interleukin 6, and High-Sensitivity C-Reactive Protein in Healthy Menopausal Women. *PLoS One.*;v.12, n.1, 2017.
- [14] JAMKA, M. et al. The effect of vitamin D supplementation on insulin and glucose metabolism in overweight and obese individuals: systematic review with meta-analysis. *Sci Rep.*; v.5, 16142, 2015.
- [15] KIELBASA, G. et al. Assessment of sleep disorders among patients with hypertension and coexisting metabolic syndrome. *Adv Med Sci.*, v. 61, n. 2, p. 261-68, 2016.
- [16] LIU, R. et al. Association between sleep quality and C-reactive protein: results from national health and nutrition examination survey, 2005–2008. *PLoS One.*; v.9, n.3, e92607, 2014.
- [17] LOHMAN, T.G.; ROCHE, A.F.; MARTORELL, R. Anthropometric standardization reference manual. Abridged Edition, 1988.
- [18] OPP, M.R. Cytokines and sleep. *Sleep Med Rev.*; v.9, n.5, p.355–64, 2005.
- [19] OZOH, O.B. et al. Prospective assessment of the risk of obstructive sleep apnea in patients attending a tertiary health facility in Sub-Saharan Africa. *The Pan African Medical Journal.*, v. 17, n. 302, p. 1-7, 2014.
- [20] PRATHER, A.A. et al. Poor sleep quality potentiates stress-induced cytokine reactivity in postmenopausal women with high visceral abdominal adiposity. *Brain Behav Immun.*; v.35, p.155–62, 2014.
- [21] PRINZ P.N.; BAILEY S.L.; WOODS D.L. Sleep impairments in healthy seniors: roles of stress, cortisol, and interleukin-1 beta. *Chronobiol Int.*; v.17, n.3, p.391–404, 2000.
- [22] RUIZ, A.J. et al. The associations between sleep disorders and anthropometric measures in adults from three Colombian cities at different altitudes. *Maturitas*, v. 94, p. 1-10, 2016
- [23] SADEGHI, M. et al. Assessing Metabolic Syndrome Through Increased Heart Rate During Exercise. *Acta Med Iran.*; v.54, n.11, p.724-730, 2016.
- [24] SALTIEL, A.R.; OLEFSKY, J.M. Inflammatory mechanisms linking obesity and metabolic disease. *J Clin Invest.*, v.127, n.1, p.1-4, 2017.
- [25] SOLER, X. et al. Age, gender, neck circumference, and Epworth sleepiness scale do not predict obstructive sleep apnea (OSA) in moderate to severe chronic obstructive pulmonary disease (COPD): The challenge to predict OSA in advanced COPD. *PLoS One.*, v. 16, n. 5, p. 1-12, 2017.
- [26] SPIEGEL, K. et al. Brief communication: Sleep curtailment in healthy young men is associated with increased leptin levels, elevated ghrelin levels, and increased hunger and appetite. *Ann Intern Med.*, v. 141, n. 11, p. 846-50, 2004.
- [27] ZAHID H.; SIMPSON E.R.; BROWN K.A. Inflammation, dysregulated metabolism and aromatase in obesity and breast cancer. *Curr Opin Pharmacol.*; v.31, p.90-96, 2016.

HidroSmart: Water Control and Preservation System

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Abstract—The HydroSmart consists of a system of control and quantification of rainwater, focused on the economy and awareness of water resources, minimizing the withdrawal of the same from the sources and distributors. The system is controlled through a microcontroller programmed to send commands to the water network of a residence. At the same time, the system will send information to a Smartphone via bluetooth. The article will show the step-by-step construction of the HydroSmart prototype to test the feasibility of the system. Thus, with the use of the application the user can access the water consumption. The good performance of the system and the application is an excellent tool that uses the technology to preserve the environment.

Keywords—Arduino Uno, Water Control.

I. INTRODUCTION

The change in the rainfall regime on the planet caused by global climate change [1] has also influenced the precipitation regime in Brazil, which could be evidenced by the supply crises in the cities of São Paulo and Minas Gerais in Brazil, in the years of 2014 and 2015 [2]. The supply crisis in the states of the southeastern region of Brazil has caused impacts in several sectors of society such as agriculture, industry and electric energy [3].

The 2015 drought was so severe that it left several cities in the southeastern region without water for days or even weeks, which led the population to seek sustainable alternatives to water use. In order to raise awareness, reduce costs and preserve the environment, technologies for the sustainable use of water have been developed, such as rainwater harvesting in homes and public buildings, reuse of water from air conditioners and household appliances such as washing machines and other.

Although the Amazon region has high rainfall levels, reaching 900 mm during the transition months [4], climate change has also affected rainfall in the region, such as the 2005 drought that caused several rivers to dry up causing death of several aquatic species. On the other hand, the occurrence of torrential rainfall in large cities and the soil sealing process is a consequence of urbanization, which prevents rainwater from infiltrating, increasing surface runoff and causing flooding areas, urban

drainage problems, and at the same time decreasing groundwater reserves [5], showing the other face of climate change. These extreme events, followed by events of long periods of drought and water shortages, lead society to think of sustainable ways to use water resources, such as rainwater harvesting.

The technology is a strong ally of sustainable practices, having as one of the main tools automation systems [6][7] and applications for mobile phones [8]. Thinking about this problem, this work will show an option of rainwater control and preservation system, called *HidroSmart*.

HidroSmart is an interactive system that adds rainwater harvesting, controlling and directing the consumption of water in a residence through the use of a Smartphones application, through which we will try to reduce the waste of water in the residence. In addition, the system still quantifies and shows in a simple way how the user can reduce their daily water consumption, reducing thus, the costs of the water bill and in parallel, reinforce for the population a more sustainable awareness. Through the installation of *HidroSmart* in any Smartphone the application will show the consumption of water to the day, month and even the year inside a residence, as it will reuse the rainwater, preserving and guaranteeing the preservation of the water sources.

Thus, this paper will show in section II the construction of the methodology, the materials used during the construction of the prototype and the tests performed with it, and finally in section III we will show the results achieved during the tests with the prototype, in addition to the expected results in one single family residential system, and finally section IV will show a summary of the most significant results presented by the *HidroSmart* system.

II. MATERIAL AND METHODS

The modeling, development, construction and testing of the *HydroSmart* prototype were carried out during the period from August to October 2018, at the premises of Universidade Paulista - UNIP. The steps that will be described next: II.1, will be shown some of the materials used in the construction of the prototype, while in II.2 a description of the hydraulic system of the *HydroSmart* will be carried out, being this separated into: network 1, which shows the path of the water coming from the concessionaire and the network 2: rainwater. In addition, section II.3 will show the structure of the *HidroSmart* application, which counts the general water consumption of the residence.

3.1 MATERIAL

The system was designed with the proposal of being simple and low cost, so that it can be implemented in single family homes in the future. By implementing the *HydroSmart* you can achieve great savings on the water bill of the residence in which the system was installed. With this in mind, we tried to use the materials available in the market which we tried to associate with characteristics such as durability, quality and low cost. Therefore, Table 1 shows the list of materials used in the construction of the *HydroSmart* prototype and its respective cost in Manaus during the second half of 2018 (updated value with the value of the dollar on 09/05/2019).

3.2 METHODOLOGY

The hydraulic project consists of two water supply networks (Figure 1), one in which the water source is the utility responsible for the distribution of water in the city, and a second, where the source of the water is the rainwater captured, both controlled by a system of Arduino circuit, which counts the water consumed by the two networks will send to a SmartPhone application.

Table 1: Bill of materials used to build the *HydroSmart* prototype, and costs

Material	Quantity
Pipe of ½	1
Plywood	1
Clamp	10
Water Tank of the 5 L	2
Water Tank of the 10 L	2
Arduino	1
FlowSensor	1
Relé Module 5V of the 2 Channels	1
Waterlevel sensor	2
Bluetooth Module	1
SolenoidFlowValve	2
Power Supply of the 12V	1
Box Adapter	7
Power Supply of the 9V	1
WaterTap	3
White Pipe of the 50 mm	1
Total Cost of Materials	\$ 6.494,76

Source: Authors, (2019).

3.2.1 NETWORK – 1

The hydraulic network of the utility will supply the water that will pass through a solenoid valve and will be at the entrance of the water tank. In this way, the valve will be connected to a flow sensor that will be installed inside the water box which can open or close the water supply system, as well as verify the water consumption. Also, this valve will control the water level, not allowing this overflow, at the same time, through this control will never lack water from the utility in the reservoir of the residence. So that the water of the concessionaire does not lack, in the exit of the box of water will be installed a sensor of flow that will make the reading of passage of the fluid through electrical pulses, thus sending the information to an Arduino Mega circuit.

The electronic prototyping platform used is a single, free board hardware, with 54 pins of digital inputs and outputs, 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a power input, a USB connection and an ICSP connection [6]. Its programming is carried out through C++ Software which is responsible for performing the calculations of the passage of water in days, weeks and even months and years. The water used by the system can be used for washing and preparing food and washing clothes and at the end of this system has a flow

valve that will be closed and will only open in the absence of water in the rainwater catchment tank.

3.2.2 NETWORK – 2

Network-2 is the rainwater collected through a gutter installed on the roof of the residence directing all the water collected to a reservoir, where an extravasor installed in the reservoir does not allow the water to overflow. At the same time, a level float will also be

installed in the rainwater reservoir. When the rainwater tank is too low and the remaining fluid can not be used, there will be a flow transfer to Network-1 (water from the utility). Thus, the water will pass through the flow sensor that will count the consumption being controlled by a mobile application. The transport of the water to the reservoir is carried out by means of a hydraulic pump of 127 Volts.

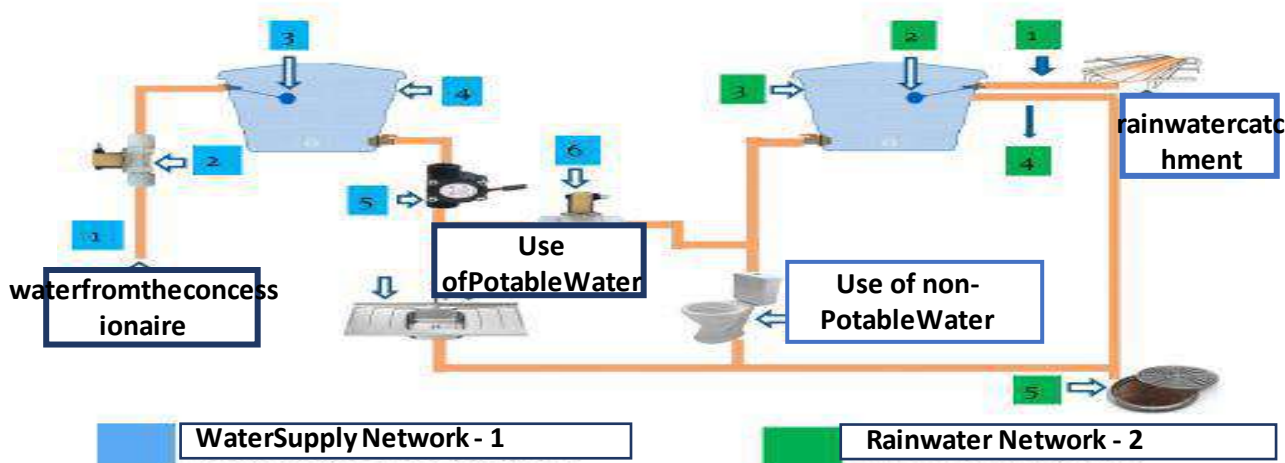


Fig.1: Project Diagram.

Source: Authors, (2019).

Table 2: Label of the Network-1 and Network -2

Network 1 – Concessionaire		Network 2 - Rainwater Harvesting	
1	PVC Pipe of the ½	1	Pipe of the ½
2	Solenoid Flow Valve	2	Water level sensor
3	Water level sensor	3	Water Tank of the 10 L
4	Water Tank of the 10 L	4	Extravasor
5	Flow Sensor	5	Sewer
6	Solenoid Flow Valve		

Source: Authors, (2019).

Table 3: Legend of the Components.

Components	
1	Power Supply of the 9V
2	Relé Module 5V of the 2 Channels
3	Solenoid Flow Valve
4	Solenoid Flow Valve
5	Water level sensor
6	Bluetooth Module
7	Arduino
8	Flow Sensor
9	Water level sensor

Source: Authors, (2019).

Interconnection of networks – Networks 1 and 2 will be interconnected through a solenoid valve that will always be closed, but at the same time, the communication of each Network and the interaction between them is controlled by a level sensor installed in the rainwater box lack of water in the reservoir.

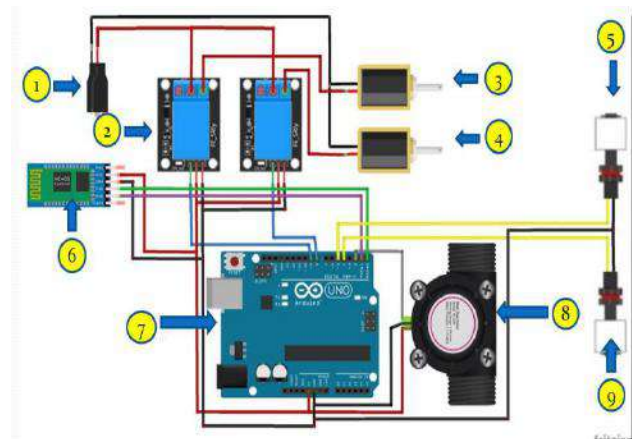


Fig.2: HidroSmart electric scheme.

Source: Authors, (2019).

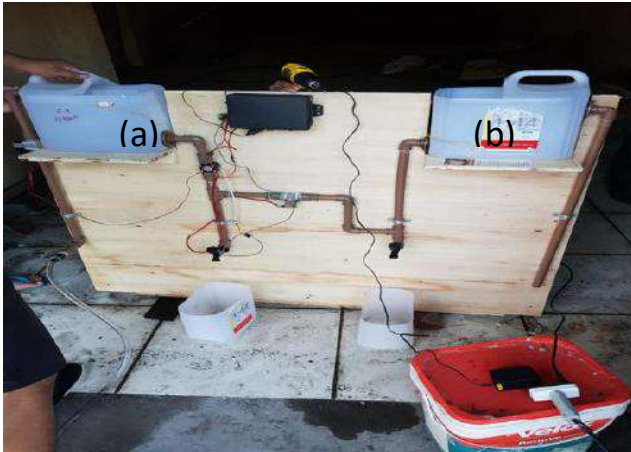


Fig.3: Prototype Assembly. a) Network-1; Simulation of the water reservoir from the concessionaire; b) Network-2; Simulation of the rainwater reservoir.

Source: Authors, (2019).

3.2.3 ROBOREMOfREE

The daily / monthly / annual consumption of water by the user is controlled through a remote-control application (Figure 4), used in Arduino-based projects. Robotooth is a 100% free platform, with no ads or user information collection, at the same time, is limited to 5 items per interface (not counting the menu button, text fields and touch stoppers).

The plots of the can display the real-time data of the sensors, and can be connected to the Arduino board directly through the OTG cable (if the device supports OTG), or use a wireless module which can connect through Bluetooth (Bluetooth SPP -BlueSMIRF, HC-05, HC-06, BTM-222, etc., and / or bluetooth low energy BLE - CC2540, CC2541, etc.) or Wii-Fi.

RoboRemoFree allows real-time control of the flow of water passing through the sensor identified by position "6" in Figure 3, which are converted into the application screen in liters via Bluetooth.

Use plots to display real-time data from sensors, which can be connected to the Arduino board directly using the OTG cable (if the device supports OTG), or the wireless module can be used and connect over Bluetooth or WiFi [10].

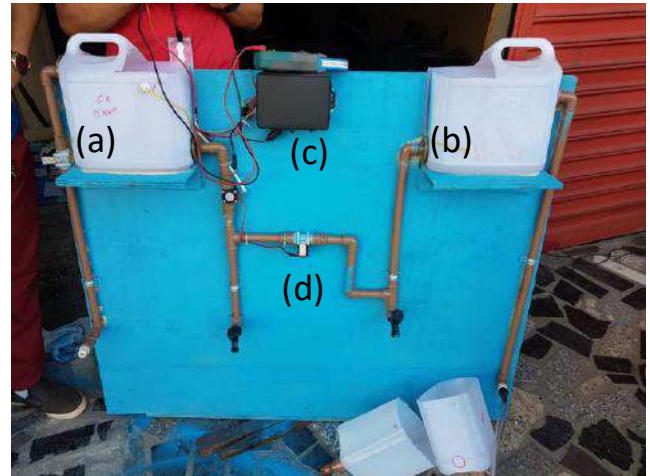


Fig. 6: Prototype. a) Network-1 - Simulation of the water reservoir from the concessionaire; b) Network-2 - Simulation of the rainwater catchment; c) Arduino system; d) control valve.

Source: Authors, (2019).

III. RESULTS

The tests with the prototype were performed in two stages. At first, only the hydraulic system was tested, verifying the incoming and outgoing flows of water from the utility (Figure 5a) and the reservoir (Figure 5b). Once the efficiency of the interaction between the two networks (utility flow and rainwater flow) was confirmed, the Arduino system was implemented, thus showing the first reports of water consumption sent to the application (Figure 7a). Each water outlet was tested separately (Figure 7b).

Through the flow valve it was possible to account for the water consumption of the two reservoirs. The information of the total water consumed in liters/minutes is sent via Bluetooth to the user's smartphone. The losses of water have a direct relation with the energy consumption, thus it was necessary about 0.6 kWh for the use 1m³ of drinking water. This shows that both hydraulic and energy efficiency are key to the proper management of water supply systems.

Figure 7a shows the result of the real-time estimate displayed on the Smartphone screen, in liters per minute of water consumption. Note that when it shows buoy 1 on the screen, it indicates that the valve is releasing the passage of the waters coming from the concessionaire. On the other hand, when this system is deactivated the information that will appear on the screen will be referred to float 2. In Figure 7a, float 1 is activated, releasing the water passage showing a consumption estimate of 2.55 L/min, and subsequently 2.36 L/min.

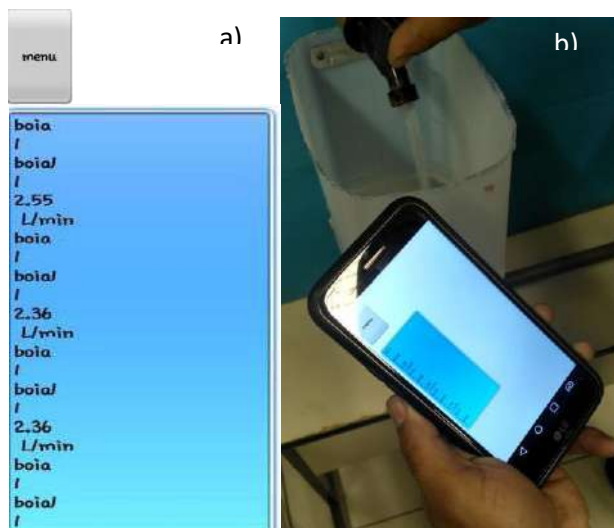


Fig. 7: a) Main screen showing water consumption (liters/min); b) Validation test of water consumption and measured by APP.

Source: Authors, (2019).

Because of the pollutants released daily into the atmosphere, it is not possible to use rainwater for potable purposes, so water collected and stored on Network-2 and used by HydroSmart will be for non-potable purposes only, such as a toilet (6 liters in each use), car wash (average 216 liters in each wash), sidewalk washing (279 liters), gardening (250 liters). Although tests with the HydroSmart prototype showed excellent results and an apparent economy, it was not installed in a residence.

IV. CONCLUSION

During the last decades, society has become aware of the importance of the conscious use of drinking water present in rivers, lakes and even in our homes. The last two droughts in the southeastern and northern regions of the country led the big cities to think about alternative ways of preserving and collecting rainwater. In addition, the latter events require increased attention, showing a strong concern about the waste and the costs of these charged by the concessionaires. Thinking of ways to minimize wastage and sustainable forms that has created HidroSmart.

Using materials that are easy to access and purchase for any user, the system has been constructed in a way that does not modify the characteristics of the original hydraulic system of the residence. The system uses two Networks; Net-1, a potable water flow system, which uses only water from the utility; and the Net-2 rainwater system, used only in toilets, car washes and outside areas of the residence and gardening. The opening and closing of

the water flow of the networks performed through a valve controlled by an Arduino system.

The flow and water consumption of the two Networks are monitored via Smartphone. RoboRemoFree is a public domain application, free and easy to access to any user. The application is the way in which the Arduino sends the user his or her water consumption every minute. Sending the lit / min information is performed every 60 seconds on the Smartphone screen. At the same time, this information will be stored and made available at the end of each month showing the user the water consumption of the utility.

The project is a way to improve water consumption in homes, leaving portions of pipelines programmed to make distributions in strategic locations and receive rainwater, not only having the primary function of combating water waste, but also generating savings in invoices from water utilities.

Through this tool the user can request information about the water consumption of his residence 24 hours a day, so he can change his habits in situations of water rationing.

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REFERENCES

- [1] Marengo JÁ. Water and Climate Change. *Advanced Studies* 22 (63): 83-95, 2008.
- [2] Coelho, C.A.S., Cardoso, D. H. F. & Firpo, M.A. F. (2016). The drought of 2013 to 2015 in the southeastern region of Brazil. *Climanálise - Special Edition of 30 years*, p. 55-61.
- [3] Jacobi, P. R., Cibim, J., Leão, R. S. Water crisis in the Macrometropole Paulista and civil society responses. *Advanced Studies*. 29 (84), 2015.
- [4] Ficsch, G., Marengo, J. A., Nobre, C. A. A general review of the Amazonian climate. *Acta Amazonica* 28 (2), 101-126, 1998.
- [5] Tucci, Carlos E. M. *Hydrology: Science and Application*. 4th edition. Porto Alegre, publisher of UFRGS, 2013.
- [6] Trojan, F., Kovaleski, J. L. *Automation in water supply: A tool to reduce losses and improve working conditions*. XII SIMPEP, Bauru, SP, 2005.
- [7] What do you think? *Automation in basic sanitation: different needs for the same objective*. *Revista Controle & Instrumentação*, ed. 61, São Paulo, SP, 2001.
- [8] Araújo, M., Cerqueira, M. A., M., Silva, A. B. L., Barbosa, C. L. M., Cordeiro, R. M. *Droplless App - Sustainable Use of Water Through Smartphones*. XXII Expocom 2015 Award, in the Communication and Innovation category. 2015. Available

<http://www.portalintercom.org.br/anais/nordeste2015/expo-com/EX47-2619-1.pdf>

- [9] Silva, A.D.C., Rocha, LV., Machado, A.P., Gutierrez, D.M.G., Santos, L.S., Gutierrez, C.B.B. Automation system for rainwater harvesting and residential water management using mobile application. Spaces. v 38 (2), 101-126, 2017.
- [10] Gonçalves, R. A. S. Web Development using Web Standards and Technologies. Degree in Systems Engineering and Informatics, Jean Piaget University of Cape Verde, Praia City, January 05, 2010.

Discomalleolar Ligament: A Review with a clinical Approach

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Abstract— *The discomalleolar ligament is described as a fibrous connection that anatomically and functionally relates the malleus bone in the middle ear to the posteromedial portion of the joint capsule through the petrotympanic fissure. It is a structure that presents important clinical aspects, since it may be related to otologic symptoms in temporomandibular joint dysfunctions. The objective of the present study was to perform a systematic review of the presence of the discomalleolar ligament, its possible influences on otologic symptoms and correlation with temporomandibular dysfunction. The analyzed sources of the literature review were searched in PubMed, Scielo, Web of Science, Lilacs, Google Scholar and Ebsco databases through a combination of keywords. An analysis of anatomical specimens was performed through the inspection of 277 adult skulls and 9 infant skulls, in order to verify the presence of foramina in the petrotympanic fissure on both sides. A computed tomography image was included in this study and showed a hypodense circular structure suggestive of foramen and possible passage of this ligament towards the disc of the temporomandibular joint. The evaluation of the anatomical parts showed that the adult skulls analyzed, about 90% had a foramen on both sides, 1.44% on the right side only, 4.33% on the left side only and 3.61% did not present foramen in any of the sides. About the children's skulls, 33.3% had a foramen on both sides, 33.3% on the right side and 33.3% had no foramen on either side. In results, the methods evaluated and the studies analyzed show the anatomical relationship between the tympanic cavity and*

temporomandibular joint, as well as the existence of the discomalleolar ligament and its possible influence on the otologic symptoms caused by temporomandibular disorders.

Keywords— *Temporomandibular joint, Malleus, Middle ear, Temporomandibular joint disorders.*

I. INTRODUCTION

The stomatognathic system is closely related anatomically and ontologically to the region surrounding the middle ear structures (RAMÍREZ ARISTEGUIETA, BALLESTEROS ACUÑA, & SANDOVAL ORTIZ, 2009)(RODRÍGUEZ VÁZQUEZ, J, MERÍDA VELASCO, J, & JIMÉNEZ COLLADO, 1993). The discomalleolar ligament is one of the fibrous connections that relates the malleus to the posteromedial portion of the temporomandibular joint capsule (PINTO, 1962), is also described as a triangular-shaped band of connective tissue whose base is continuous with the posterior region of the joint capsule and disc, which is directed to the middle ear through the petrotympanic fissure (COLEMAN, 1970).

Little mentioned in the anatomy books (MORGAN, 1982)(BOCHENEK & REICHER, 1997)(STANDRING, 2005)(ALVES & DEANA, 2010), the discomalleolar ligament was first referred to in 1954 (REES, 1954), but its detailed description was performed in 1962 and is also described and demonstrated by several other authors (PINTO, 1962). It is a structure that penetrates the caudal end of Meckel's cartilage corresponding to an embryological remnant of the lateral pterygoid muscle (CHEYNET, GUYOT, RICHARD,

LAYOUN, & GOLA, 2003). However, other researchers stated that Meckel's cartilage has no influence on the development of the temporomandibular joint and also that during the embryonic stage there is no evidence that the lateral pterygoid muscle attaches to the malleus (FURSTMAN, 1963)(YUODELIS, 1966).

The discomalleolar ligament is a structure that presents important clinical aspects (ALVES & DEANA, 2010). Some authors state that dysfunctions in the temporomandibular joint (TMD) cause alteration of the discomalleolar ligament, causing a displacement of the malleus, resulting in some symptoms such as tinnitus and deafness (PINTO, 1962)(IOANNIDES & HOOGLAND, 1983). Although the risks of otological symptoms are greater in individuals presenting with disorders such as pain during the opening and closing of the mouth or palpation of the temporomandibular joint (PASCOAL, 2001)(LAM, LAWRENCE, & TENENBAUM, 2001). The origin and possible relations between these structures are not fully understood (FELICIO, FARIA, & DA SILVA, 2004). This structure can usually be observed in dissected anatomical pieces. However, it is also possible to visualize it in concomitant computed tomography in sagittal sections. In the images, furthermore to discomalleolar ligament, structures related to temporomandibular joint are also observed within the petrotympanic fissure. In Cone Beam CT images, the petrotympanic fissure resembles a small lumen that extends in the direction of the epitympanic recess in the upper portion of the tympanic cavity, where inferiorly the malleus bone is located. Studies demonstrate the visualization in tomographic images and anatomical pieces that discomalleolar ligament connects to the head and anterior region of the malleus bone, disposed from the posterior and superior portion of the mandibular fossa, located in the temporal bone (ARAI & SATO, 2012).

Thus, the aim of the present study was to perform a systematic review of the presence of the discomalleolar ligament, its possible influences on otologic symptoms and correlation with temporomandibular dysfunction.

II. MATERIALS AND METHODS

2.1 Computed tomography (CT)

A computed tomography image was used to evaluate the presence of the discomalleolar ligament. The image covers the region of a temporomandibular joint on the left side and was obtained by a scanner I-CAT CT (Cone Beam Volumetric Tomography [I-CATVisionProgram]).

2.2 Anatomical Pieces Evaluation

This stage was based on a careful evaluation of skulls belonging to the Department of Biological Sciences, Anatomy Discipline of School of Dentistry of Bauru- University of São Paulo (FOB-USP). The inspection of the pieces was done with the naked eye and with the aid of a hand magnifier with lighting 75 mm in diameter and increase of 6 times, of the brand Western 3455. It consisted in identifying the presence or absence of foramina in the region of the petrotympanic fissure on the left and right sides of 277 (two hundred and seventy-seven) adult skulls and 9 (nine) children skulls.

2.3 Data source

This literature review contains information available in the databases PubMed, Scielo, Web of Science, Lilacs, Google Scholar and Ebsco, using the following keywords: discomalleolar ligament / discomalleolar ligament, temporomandibular disorders, temporomandibular dysfunction, and petrotympanic fissure. This led to the initiation of a search strategy and articles published between 2006 and 2016 were included, using a keyword search to obtain information about the discomalleolar ligament (figures 1-6).

2.4 Data extraction

After analyzing and reviewing the researched scientific articles, ten relevant studies related to the objectives of the study were found. Several studies resulting from the research were read with the objective of identifying relevant information on the subject in question.

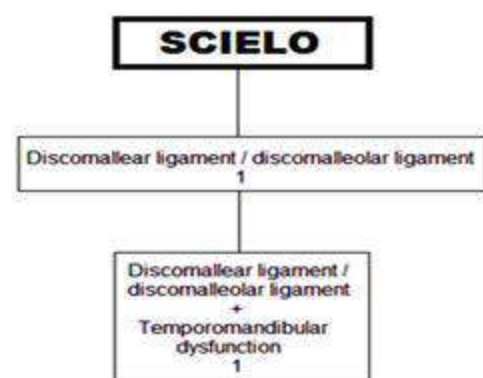


Fig.1: Scielo Keywords combination.

Papers extracted from the Scielo database:

1- Frequency of occurrence of the discomalleolar ligament in the adult man (ALVES; DEANA, 2010).

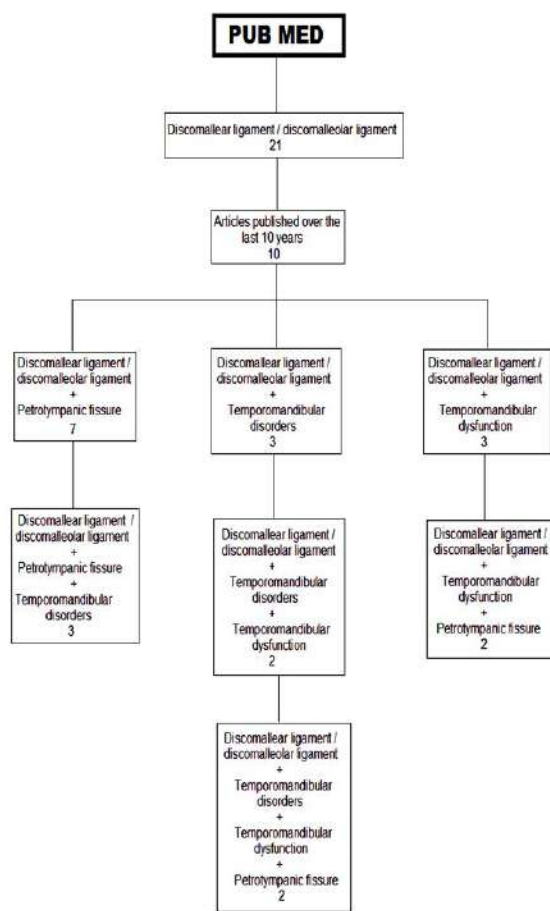


Fig.2: PubMed Keywords combination.

Papers extracted from the PubMed database:

- 1- Prevalence of the types of the petrotympanic fissure in the temporomandibular joint dysfunction (ÇAKUR et al., 2011).
- 2- Classifications of tunnel-like structure of human petrotympanic fissure by cone beam CT (SATO et al., 2008).

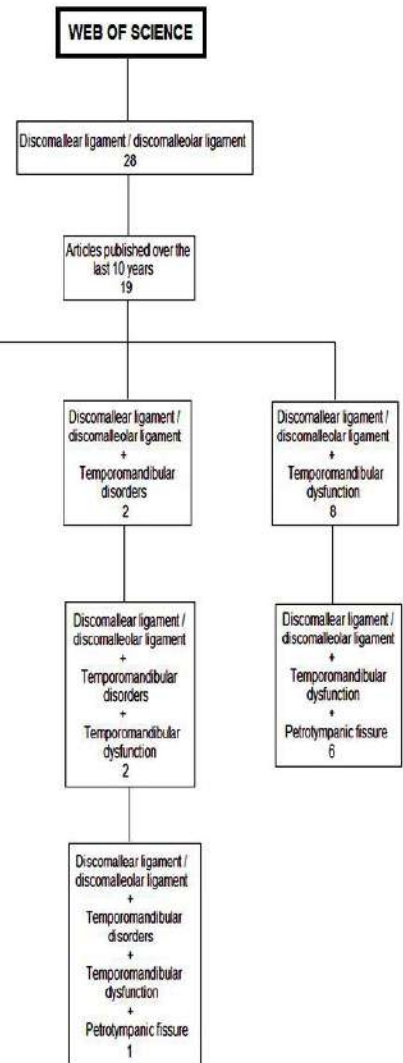


Fig.3: Web of Science Keywords combination.

Papers extracted from the Web of Science database:

- 1- Correlation between tinnitus and petrotympanic fissure status among patients with temporomandibular joint dysfunction (ÇAKUR; YASA, 2016).

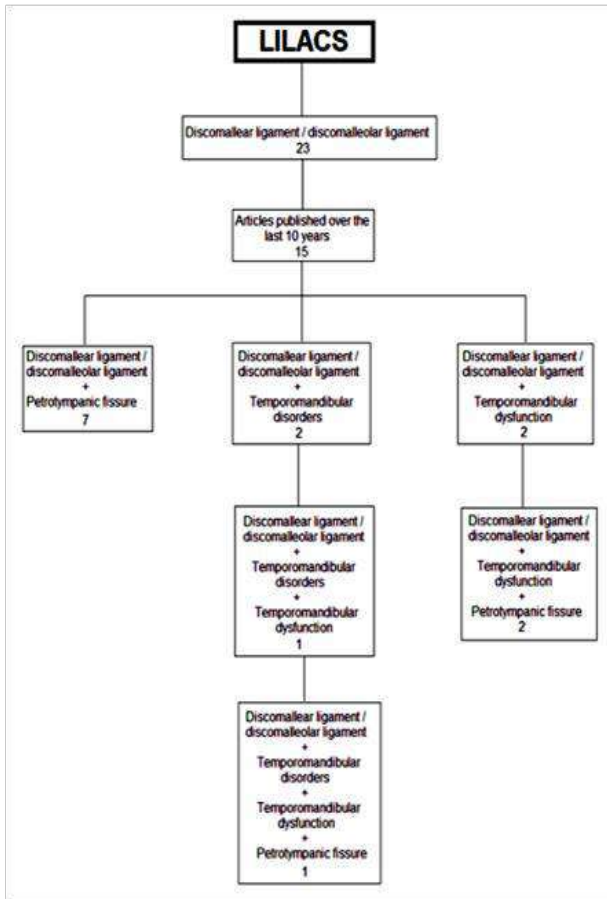


Fig.4: LILACS Keywords combination.

Papers extracted from the LILACS database:

1- Classifications of tunnel-like structure of human petrotympanic fissure by cone beam CT (SATO et al., 2008).

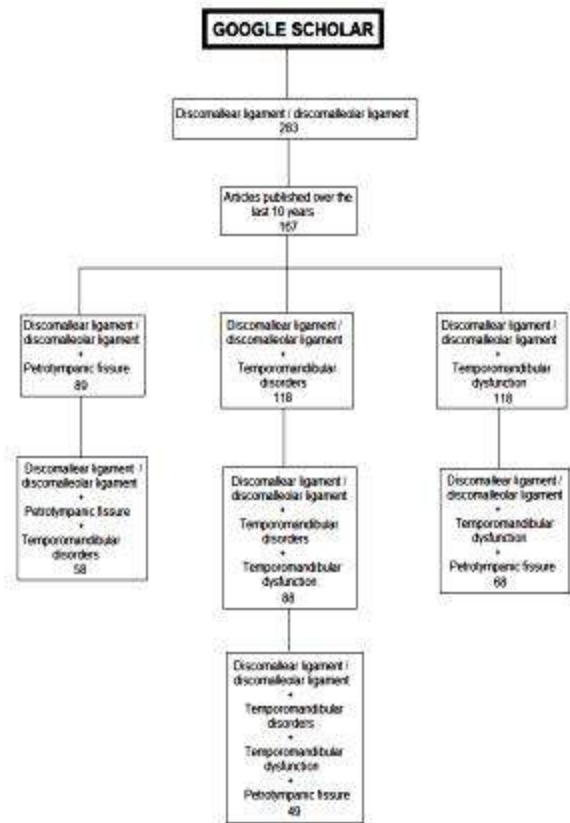


Fig.5: Google Scholar Keywords combination.

Papers extracted from the Google Scholar database:

- 1- A direct anatomical study of the morphology and functionality of disco-malleolar and anterior malleolar ligaments (ARISTEGUIETA; ACUNA; ORTIZ, 2009).
- 2- Anatomical study of the human discomalleolar ligament using cone beam computed tomography imaging and morphological observations (ARAI; SATO, 2011).
- 3- A study of the discomalleolar ligament in the adult human (ROWICKI; ZAKRZEWSKA, 2006).

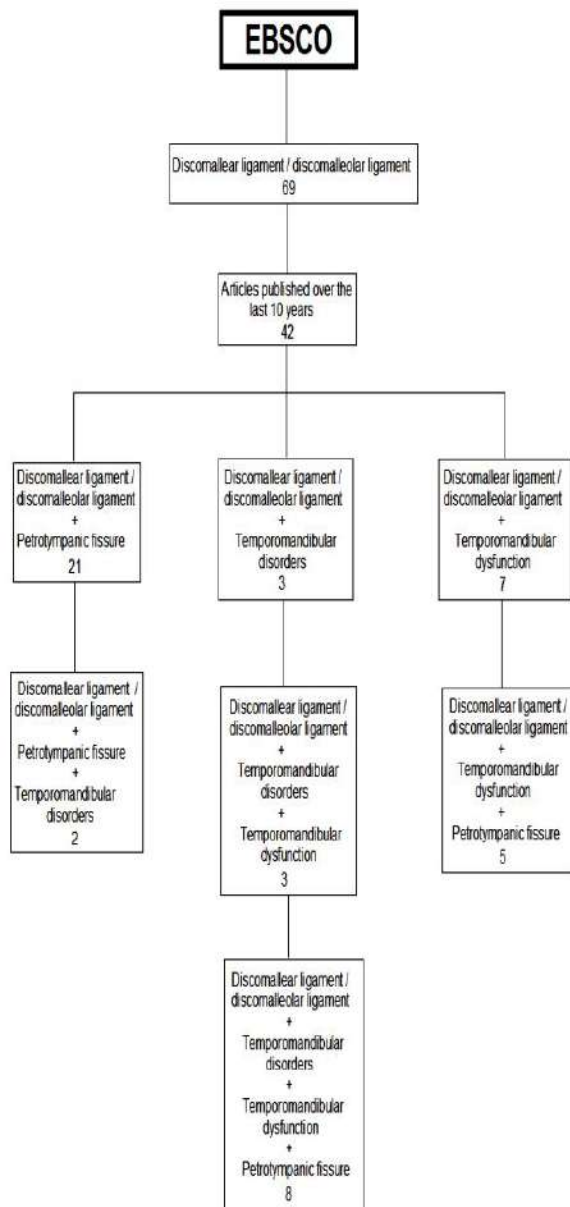


Fig.6: EBSCO Keywords combination.

Papers extracted from the EBSCO database:

- 1- Anatomical and functional aspects of ligaments between the malleus and the temporomandibular joint (SENCIMEN et al., 2008).
- 2- Signs and Symptoms of Temporomandibular Joint Disorders Related to the Degree of Mouth Opening and Hearing Loss (KITSOULIS et al., 2016).
- 3 - Ossification of the petrotympanic fissure: morphological analysis and clinical implications (MONTEIRO; ENNES; ZORZATTO, 2011).

III. RESULTS

Computed tomography (CT) and Anatomical Pieces Evaluation

It can be observed that the tomographic image (figure 7) used in the present study has a circular hypodense structure, in the region of the petrotympanic fissure, near the mandibular fossa of the temporal bone, suggestive of foramen and a possible passage of the discomalleolar ligament towards posterior region of the joint capsule of the disc of the temporomandibular joint.

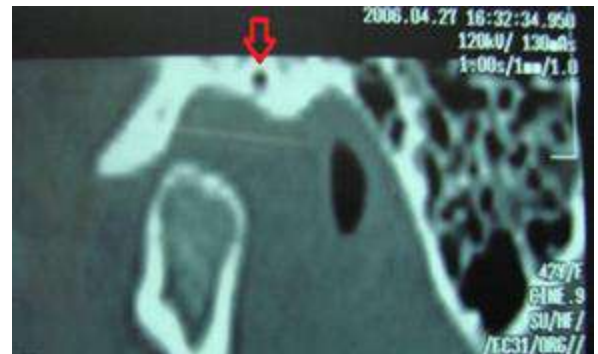


Fig.7: Possible place of passage of the discomalleolar ligament demonstrated by the red arrow.

The evaluation of the skulls resulted in two tables, one for adult skulls (table 1) and one for children's skulls (table 2). About adult skulls analyzed, 90% presented foramen on both sides, 1.44% presented foramen only on the right side, 4.33% presented foramen only on the left side, and 3.61% presented no foramen on either side. Of the children's skulls, 33.3% had a foramen on both sides, 33.3% on the right side, and 33.3% had no foramen on either side. Two images were obtained (Figures 8 and 9) in order to demonstrate to the naked eye, the presence of the foramina in the petrotympanic fissure.

Table 1: Analysis of absence or presence of foramen in the region of petrotympanic fissure in adult skulls.

	BOTH SIDES	JUST ON THE RIGHT SIDE	JUST ON THE LEFT SIDE
ABSENCE OF FORAME	10	X	X
PRESENCE OF FORAME	251	4	12

Table 2: Analysis of absence or presence of foramen in the region of petrotympanic fissure in children's skulls.

	BOTH SIDES	JUST ON THE RIGHT SIDE	JUST ON THE LEFT SIDE
ABSENCE OF FORAME	3	X	X
PRESENCE OF FORAME	3	3	0



Fig.8: Presence of foramen in the petrotympanic fissure on the right side, demonstrated by the red arrow.



Fig.9: Presence of foramen in the petrotympanic fissure on the left side, demonstrated by the red arrow.

Literature review

After analyzing the combination of the keywords used for this literature review, a table with a brief summary of each of the extracted papers was obtained (table 3).

Table 3: Summary of Articles included in this Review.

Authors	Objective	Methods	Results	Conclusion
Çakur et al. (2011)	To investigate the prevalence of petrotympanic fissure types in temporomandibular dysfunction with dental tomography and correlation with age.	134 TMD patients examined for type of petrotympanic fissure by means of dental tomography. Three types were described: wide tunnel structure (type 1); tunnelled structure at the entrance of the petrotympanic fissure that gradually decreases towards the tympanic cavity (type 2), a tunnel-shaped structure that is well open at the entrance of the mandibular fossa, with a flat shape in the middle and a narrow exit in the tympanic cavity (type 3).	In the DVT (dental tomography) scans, PTF (petrotympanic fissure) types 1, 2 and 3 were observed in 67.2%, 1.5% and 31.3% of the cases, respectively. We found no significant relationship between age or gender and PTF type`.	The low percentage of type 2 PTF and high percentage of type 1 PTF should be taken into account during pre-surgery planning related to TMD.
Sato et al. (2008)	To define the morphological characteristics of the discomalleolar ligament by Cone-Beam Computed	The CBCT of PSR 9,000 N (Asahi Roentgen Industry, Kyoto, Japan) was used to acquire temporomandibular	The CBCT images revealed three types of structures in the middle region of the petrotympanic fissure toward the malleus	The structures are important to define the malleus limited movement and the morphological characteristic of the

	Tomography (CBCT) and the anatomical dissection of Japanese cadavers.	joint images of 14 human cadavers that later had this region dissected.	bone: wide tunnel (29.2%, 7/24, type 1), a widely open tunnel form at the entrance of the petrotympanic fissure (20.8%, 5/24, type 2), and the tunnel form is widely open at the entrance of the mandibular fossa, with a tunnel and flat form in the middle and narrow exit in the tympanic cavity (41.7% 10/24, type 3).	ligaments in this bone may be related to temporomandibular joint pain, dysfunction and auditory function.
Alves et al. (2010)	To determine the frequency of occurrence of the discomalleolar ligament in the adult man.	20 hemi-heads dissected with the purpose of exposing the articular disc, ossicles of the middle ear, lateral pterygoid muscle and other structures of the region.	In all cases, the malleus and disc of the temporomandibular joint were connected by ligaments that formed a fibrous structure in the form of a thin blade.	The discomalleolar ligament was found in all cases and may be considered an intrinsic ligament of the temporomandibular joint.
Çakur et al. (2016)	To evaluate the correlation between tinnitus and petrotympanic fissure subtypes in patients diagnosed with temporomandibular joint dysfunction (TMD).	100 patients with TMD (50 with tinnitus, 50 without tinnitus) underwent concomitant computed tomography (CBCT) had the images analyzed and petrotympanic fissure classified as type 1 (wide tubular formation), type 2 (double conical structure) or type 3 (single conical structure).	Although there was a negative correlation between tinnitus and petrotympanic fissure type ($P < 0.001$), there was no correlation between age and tinnitus or between age and petrotympanic fissure subtype. There was no significant association between gender and tinnitus or petrotympanic fissure ($P > 0.05$).	A short and broad petrotympanic fissure (type 1) may be associated with a higher incidence of tinnitus in patients with TMD.
Ramirez et al. (2009)	Study of morphometric and functional aspects of anterior discomalleolar and malleolar ligaments.	3 temporal bone pieces of 12 cadavers were microdissected to expose ligaments under study. Electronic caliber (Mitutoyo) for recording measurements in mm and applying forces to the mandible for reproduction of some physiological and	Mean lengths of the anterior discomalleolar and malleolar ligaments of 6.88 mm (SD 0.81) and 4.22 mm (SD 1.17), respectively. Malleus movement with discomalleolar traction in 30.5% of samples. Correlation between the movement of the malleus and the length of the discomalleolar (R2	There was an anatomic and functional relationship between the human temporomandibular joint and the middle ear.

		pathological scenarios.	= -0.499, p <0.05). Both ligaments present in all specimens.	
Arai et al. (2011)	Study of the morphological, macroscopic, histological structure of the discomalleolar ligament (DML) and evaluation of neuronal structures within the distribution of substance P (SP) and peptide related to the calcitonin gene (CGRP).	Dissection and extraction of temporal bones containing the temporomandibular joint of 27 human cadavers. Parts submitted to concomitant computed tomography, measurements and immunohistochemical methods.	The posterior area of the DML articulates with the head and anterior process of the malleus through the petrotympanic fissure, forming a narrow channel. This was associated with bone mobility. In the anterior and posterior connective tissue of the DML associated with the disc, fibers of the nerves CGRP-, PGP9.5- and SP-positive were located around numerous blood vessels.	The structure of the petrotympanic fissure by which the discomalleolar ligament attaches to the malleus, as well as the histological and radiographic profiles of its structure, showed a relation with the mobility of the malleus.
Rowicki et al. (2006)	To determine the frequency of occurrence and morphology by means of endoscopic visualization of the discomalleolar ligament (DML) and its attachments, and if the applied tension could trigger the movement of the malleus.	Evaluate of 14 samples of the temporomandibular and tympanic cavity by means of an endoscope and then by coarse dissection of an operating microscope.	4 cases had a strip of tissue in the temporomandibular joint, known as Pinto's ligament. Presence of DML in 11 cases, triangular in 7 cases, and longitudinal in 4 cases. Malleus movement present in 3 cases.	There is a clear connection between the temporomandibular joint and the tympanic cavity.

Kitsoulis et al. (2011)	Examination of the relation between signs and symptoms of temporomandibular dysfunction (TMD) and mouth opening, gender, joint and auditory symptoms and hearing loss.	464 university students. Mouth opening measured with Vernier calipers. Anamnestic questionnaire applied to stratify them into four groups based on the severity of TMD. Hearing symptoms and a recorded audiogram for each subject as well.	Overall incidence of signs and symptoms of TMD were 73.3%, higher in women (p-value 0.0001 <0.05). Hearing symptoms were associated with TMD severity (p-value 0.0001 <0.05) as well as maximum mouth opening (p-value 0.004 <0.05). Audiometry showed that moderate and severe TMD was associated with hearing loss of medium and low tones, respectively (p-value 0.0001 <0.05). TMJ pain (p value 0.0001 <0.05), TMJ ankylosis (p-value 0.0001 <0.05), bruxism (p-value 0.0001 <0.05) and ear itching (p-value 0.0001 <0.05) were also statistically different between TMD and non-TMD.	Signs and symptoms of TMD are more common and severe in women. The severity of TMD correlated with the degree of mouth opening and the number of auditory symptoms. The absence or presence of mild TMD was associated with normal audiograms, while moderate and severe TMD were related to hearing loss in low and low tones, respectively. Bruxism, joint ankylosis, joint pain and ear itching were more common in TMD than patients without TMD.
Sencimen et al. (2008)	To investigate the anatomical topography and the relation between the ligaments, malleus and temporomandibular joint and to determine the role of these ligaments in the movement of the malleus.	The malleus, incus, petrotympanic fissure (PTF), chorda tympani, anterior malleolar ligament (AML), discomalleolar ligament (DML), malleomandibular ligament, sphenomandibular ligament and disc joint were explored in 15 skulls. Tensile and tensile tests performed to clarify the role of these structures in the movement of the malleus.	In 12 cases two ligaments connected to the anterior part of the malleus. Of this same portion, another ligament that went to PTF was seen in 3 cases. In all of cases, the DML joined the retrodiscal tissues. In the other 3 cases, the medial and lateral parts of the ligament were attached to the retrodiscal tissue after passage through PTF. The thickness of the ligaments differed among the specimens. When the tension was applied to the DML, no malleolar movement	The overstretched of the condyle together with the ligaments between the inner ear ossicles and the TMJ may be the reason for unexplained otological problems.

			occurred, but when the AML was overloaded, the movement was significant in 5 corpses; small movement in 6 corpses, and no movement in 4 corpses.	
Monteiro et al. (2011)	To characterize morphologically the calcification in the petrotympanic fissure through three observations: macroscopic observation to the naked eye, stereomicroscopic observation and measurements made from digital images.	Macroscopic and stereomicroscopic analysis of the petrotympanic fissure of 30 human skulls. Analysis of scanned images with the UTHSCSA ImageTool 3.0 computer program. Measurement of the total extension of the areas of cracks and ossification.	Macroscopic analysis: areas suggestive of calcification in 27 fissures (45%). Stereomicroscopic analysis: areas of calcification in 40 fissures. (66.6%). The location of the areas of calcification was not regular considering the total length of the various fissures and their division into median and lateral regions, occurring randomly along the total length of the fissures.	Macroscopic analysis was not an appropriate method for this evaluation and the ossification of fissures increased with aging, suggesting its influence on the causes of otalgia in cases of temporomandibular joint dysfunction.

IV. DISCUSSION

The aim of the present study was to perform a systematic review of the presence of the discomalleolar ligament, its possible influences on otological symptoms and correlation with temporomandibular dysfunction. Therefore, the methods evaluated and the studies analyzed shows the anatomical relationship between the tympanic cavity and temporomandibular joint, as well as the existence of the discomalleolar ligament and its possible influence on the otologic symptoms caused by temporomandibular disorders.

In addition, several studies state that there is an obvious anatomic and functional relationship between temporomandibular joint and the tympanic cavity (RODRÍGUEZ VÁZQUEZ, MÉRIDA VELASCO, MÉRIDA VELASCO, & JIMÉNEZ COLLADO, 1998)(CHEYNET et al., 2003)(ROWICK & ZAKRZEWSKA, 2006)(RAMÍREZ ARISTEGUIETA et al., 2009) (ÇAKUR, SÜMBÜLLÜ, DURNA, & AKGÜL, 2011). The discomalleolar ligament is one of the structures that allows this relationship and is not described in anatomical books (PATURET, 1951)(SAPPEY, 1867)(CRÉPY, 1967)(TESTUT & LATARJET, 1975)(ROMANES, 1987)(ROUVIÈRE & DELMAS, 1987)(DUBRUL, 1990)(WILLIAMS, 1995). This

ligament consists of a layer of superior fibers that insert into the anterior malleus process and the bone wall of the squamous portion of the petrotympanic fissure, and a layer of inferior fibers surrounding the anterior malleolar ligament (AML), the remnant of Meckel's cartilage, the chorda tympani and insert into the tympanic wall of the temporal bone (OGÜTCEN-TOLLER, 1995). Besides, it is considered an intrinsic ligament of the temporomandibular joint (RODRÍGUEZ VÁZQUEZ, MÉRIDA VELASCO, & JIMÉNEZ COLLADO, 1992)(RODRÍGUEZ VÁZQUEZ, J et al., 1993)(RODRÍGUEZ VÁZQUEZ et al., 1998)(ALVES & DEANA, 2010).

Some authors consider discomalleolar ligament as part of AML (BURCH, 1966)(TOLEDO FILHO, ZORZETTO, & NAVARRO, 1985)(CESARIANI, TOMBOLINI, FAGNANI, & DOMENECH MATEU, 1991), superior extension of the sphenomandibular ligament in the tympanic cavity (BURCH, 1966) or the "small ligament" described by Pinto in 1962 (PINTO, 1962). In contrast, other authors do not agree with the statement that AML and discomalleolar ligament are part of the same structure and say that there is a well-established difference between them (COLEMAN, 1970)(KOMORI, SUGISAKI, TANABE, & KATOH, 1986)(OGÜTCEN-

TOLLER, 1995)(RODRÍGUEZ VÁZQUEZ et al., 1998)(Dai, Cheng, Wood, & Gan, 2007)(SENCIMEN et al., 2008).

Individuals with temporomandibular dysfunction may frequently exhibit otological symptoms. The dissonance of the stomatognathic system, such as muscular pain, TMJ pain, cervical pain, tooth sensitivity, joint noise and, in general, functional difficulties, were significantly associated with otologic symptoms in cases of temporomandibular disorders (FELICIO et al., 2004)(KITSOULIS, MARINI, ILIOU, GALANI, & ZIMPIS, 2011)(ÇAKUR & YAŞA, 2016).

The discomalleolar ligament presents mobility as it passes through petrotympanic fissure, caused by stretches in the TMJ disc during movements of the mandible (COULY & HUREAU, 1976)(CESARIANI et al., 1991)(SATO, ARAI, IMURA, KAWAI, & YOSUE, 2008)(ARAI & SATO, 2012). Consequently, it is believed that the mobility of this ligament according to the degree of closure of petrotympanic fissure determined during development may affect the movement of the middle ear bones (RODRÍGUEZ VÁZQUEZ et al., 1998). Some authors state that malleus mobility was observed when the discomalleolar ligament was overloaded (IOANNIDES & HOOGLAND, 1983)(O'RAHILLY & GARDNER, 1976)(PINTO, 1962)(TOLEDO FILHO et al., 1985). Nonetheless, other authors say that there is no evidence that discomalleolar ligament can cause movement of this ossicle chain (COLEMAN, 1970)(KOMORI et al., 1986)(LOUGHNER, LARKIN, & MAHAN, 1989)(ECKERDAL, 1991)(OGÜTCEN-TOLLER, 1995)(SENCIMEN et al., 2008).

The morphological characteristics of the ligament as well as its mobility may influence the movement of the malleus. This observation could strengthen the hypothesis of origin of pain in TMJ and of otalgia's (IOANNIDES & HOOGLAND, 1983)(RODRÍGUEZ VÁZQUEZ et al., 1998)(SATO et al., 2008)(SENCIMEN et al., 2008). Some authors have made a relation between the ligament in question and certain otologic manifestations caused by temporomandibular disorders (IOANNIDES & HOOGLAND, 1983)(Rohlin, Westesson, & Eriksson, 1985)(LOUGHNER et al., 1989)(OGÜTCEN-TOLLER & JUNIPER, 1993). Tinnitus may be due to the transmission of excessive mechanical forces by discomalleolar ligament (PEKKAN, AKSOY, Hekimoglu, & Oghan, 2010)(RAMÍREZ ARISTEGUIETA et al., 2009)(ASH, ASH, ASH, & ASH, 1990). It may also be a possible pathway for the spread of infection from the middle ear to temporomandibular joint, such as otitis media, which can, through petrotympanic fissure, cause

capsulitis or even rupture of the ossicle joint (LOUGHNER et al., 1989). In contrast, other authors say that the ligament has no role in otological manifestations (CHEYNET et al., 2003)(ALVES & DEANA, 2010), because it does not contain sufficient force to mobilize the bones of the middle ear once it is firmly adhered to petrotympanic fissure (ALVES & DEANA, 2010).

V. CONCLUSION

For this purpose, that the methods evaluated and the studies analyzed show the anatomical relationship between the tympanic cavity and the temporomandibular joint, as well as the existence of the discomalleolar ligament and its possible influence on the otologic symptoms caused by temporomandibular disorders.

REFERENCES

- [1] ALVES, N., & DEANA, N. F. (2010). Frequency of Occurrence of the Discomalleolar Ligament in the Adult Man. *International Journal of Morphology*, 28(2), 515–518. <https://doi.org/10.4067/s0717-95022010000200029>
- [2] ARAI, H., & SATO, I. (2012). Anatomical study of the human discomalleolar ligament using cone beam computed tomography imaging and morphological observations. *Okajimas Folia Anatomica Japonica*, 88(3), 89–101. <https://doi.org/10.2535/ofaj.88.89>
- [3] ASH, M., ASH, C., ASH, J., & ASH, G. (1990). Current concepts of the relationship and management of temporomandibular disorders and auditory symptoms. *J Mich Dent Assoc*, 72(11–12), 550–555.
- [4] BOCHENEK, A., & REICHER, M. (1997). *Anatomia Humana* (11th ed.). Warszawa: PZWL.
- [5] BURCH, J. G. (1966). The cranial attachment of the sphenomandibular (tympanomandibular) ligament. *The Anatomical Record*, 156(4), 433–437.
- [6] ÇAKUR, B., SÜMBÜLLÜ, M., DURNA, D., & AKGÜL, H. (2011). Prevalence of the types of the petrotympanic fissure in the temporomandibular joint dysfunction. *Acta Radiol*, 52(5), 562–565.
- [7] ÇAKUR, B., & YAŞA, Y. (2016). Correlation Between Tinnitus and Petrotympanic Fissure Status Among Patients With Temporomandibular Joint Dysfunction. *J Oral Maxillofac Surg*, 74(1), 47–52.
- [8] CESARIANI, A., TOMBOLINI, A., FAGNANI, E., & DOMENECH MATEU, J. (1991). The anterior ligament of the human malleus. *Acta Anat (Basel)*, 42(4), 313–6.
- [9] CHEYNET, F., GUYOT, L., RICHARD, O., LAYOUN, W., & GOLA, R. (2003). Discomalleolar and maleomandibular ligaments: Anatomical study and clinical applications. *Surgical and Radiologic Anatomy*, 25(2), 152–157. <https://doi.org/10.1007/s00276-003-0097-y>
- [10] COLEMAN, R. D. (1970). Temporomandibular Joint: Relation of the Retrodiskal Zone to Meckel's Cartilage and Lateral Pterygoid Muscle. *Journal of Dental Research*,

- 49(3), 626–630.
<https://doi.org/10.1177/00220345700490032701>
- [11] COULY, G., & HUREAU, J. (1976). [The oto-mensical relationship of temporo-mandibular joint in the new-born man (author's transl)]. *Arch Anat Histol Embryol.*, 59, 143–50.
- [12] CRÉPY, C. (1967). *Anatomie Cervico-Faciale*. (1st ed.). Paris: Masson.
- [13] Dai, C., Cheng, T., Wood, M. M., & Gan, R. Z. (2007). Fixation and detachment of superior and anterior malleolar ligaments in human middle ear: Experiment and modeling. *Hear Res*, 230(1–2), 24–33.
- [14] DUBRUL, E. . (1990). *Anatomia Oral*. Barcelona: Ediciones Doyma.
- [15] ECKERDAL, O. (1991). The petrotympanic fissure: a link connecting the tympanic cavity and the temporomandibular joint. *Cranio*, 9(1), 15–22.
- [16] FELICIO, C., FARIA, T., & DA SILVA, M. A. M. . (2004). Desordem Temporomandibular: relações entre sintomas otológicos e orofaciais. *Rev Bras Otorrinolaringol*, 70(6), 786–793.
- [17] FURSTMAN, L. (1963). The early development of the human temporomandibular joint. *American Journal of Orthodontics*, 49(9), 672–682.
- [18] IOANNIDES, C. A., & HOOGLAND, G. A. (1983). The disco-malleolar ligament: A possible cause of subjective hearing loss in patients with temporomandibular joint dysfunction. *Journal of Maxillofacial Surgery*, 11(C), 227–231. [https://doi.org/10.1016/S0301-0503\(83\)80053-8](https://doi.org/10.1016/S0301-0503(83)80053-8)
- [19] KITSOULIS, P., MARINI, A., ILIOU, K., GALANI, V., & ZIMPIS, A. (2011). Signs and Symptoms of Temporomandibular Joint Disorders Related to the Degree of Mouth Opening and Hearing Loss. *BMC Ear Nose Throat Disord*, 11(5).
- [20] KOMORI, E., SUGISAKI, M., TANABE, H., & KATOH, S. (1986). Discomalleolar Ligament in the Adult Human. *Cranio*, 4(4), 299–305.
- [21] LAM, D., LAWRENCE, H., & TENENBAUM, H. (2001). Aural symptoms in temporomandibular disorder patients attending a craniofacial pain unit. *J Orofac Pain*, 15(2), 146–157.
- [22] LOUGHNER, B. A., LARKIN, L. H., & MAHAN, P. E. (1989). Discomalleolar and anterior malleolar ligaments: Possible causes of middle ear damage during temporomandibular joint surgery. *Oral Surgery, Oral Medicine, Oral Pathology*, 68(1), 14–22. [https://doi.org/10.1016/0030-4220\(89\)90108-4](https://doi.org/10.1016/0030-4220(89)90108-4)
- [23] MORGAN, D. . (1982). *Diseases of the tempormandibular apparatus: A multidisciplinary aproach*. Toronto: Mosby.
- [24] O'RAHILLY, R., & GARDNER, E. (1976). *The embryology of bone and joints*. IAP.
- [25] OGÜTCEN-TOLLER, M. (1995). The morphogenesis of the human discomalleolar and sphenomandibular ligaments. *J Craniomaxillofac Surg*, 23(1), 42–6.
- [26] OGÜTCEN-TOLLER, M., & JUNIPER, R. (1993). Audiological evaluation of the aural symptoms in temporomandibular joint dysfunction. *J Craniomaxillofac Surg*, 21(1), 2–8.
- [27] PASCOAL, M. I. N. (2001). Prevalência dos sintomas otológicos na desordem temperomandibular: estudo de 126 casos. *Rev. Bras. Otorrinolaringol*, 67(5), 627–633.
- [28] PATURET, G. (1951). *Traité d'anatomie humaine* (1st ed.). Masson.
- [29] PEKKAN, G., AKSOY, S., Hekimoglu, C., & Oghan, F. (2010). Comparative audiometric evaluation of temporomandibular disorder patients with otological symptoms. *J Craniomaxillofac Surg*, 38(3), 231–234.
- [30] PINTO, O. (1962). A new structure related to the temporomandibular joint and middle ear. *The Journal of Prosthetic Dentistry*, 12(1), 95–103.
- [31] RAMÍREZ ARISTEGUIETA, L. M., BALLESTEROS ACUÑA, L. E., & SANDOVAL ORTIZ, G. P. (2009). A Direct Anatomical Study of the Morphology and Functionality of Disco-malleolar and Anterior Malleolar Ligaments. *International Journal of Morphology*, 27(2), 367–379. <https://doi.org/10.4067/s0717-95022009000200011>
- [32] REES, L. . (1954). The structure and function of mandibular joint. *Br Dent J*, 96, 125–133.
- [33] RODRÍGUEZ VÁZQUEZ, J. F., MERÍDA VELASCO, J. R., & JIMÉNEZ COLLADO, J. (1993). Relationships between the temporomandibular joint and the middle ear in human fetuses. *J Dent Res*, 72(1), 62–66.
- [34] RODRÍGUEZ VÁZQUEZ, J. ., MÉRIDA VELASCO, J. ., & JIMÉNEZ COLLADO, J. (1992). Development of the human sphenomandibular ligament. *Anatomical Record*, 233(3), 453–460.
- [35] RODRÍGUEZ VÁZQUEZ, J. ., MÉRIDA VELASCO, J. ., MÉRIDA VELASCO, J. ., & JIMÉNEZ COLLADO, J. (1998). Anatomical considerations on the discomalleolar ligament. *J Anat*, 192(4), 617–621.
- [36] Rohlin, M., Westesson, P., & Eriksson, L. (1985). The correlation of temporomandibular joint sounds with joint morphology in fifty-five autopsy specimens. *J Oral Maxillofac Surg*, 43(3), 194–200.
- [37] ROMANES, G. J. (1987). *Cunningham Tratado de Anatomia*. Madrid: Interamericana-McGraw-Hill.
- [38] ROUVIÈRE, H., & DELMAS, A. (1987). *Anatomia Humana: Descriptiva, Topografica y Funcional* (1st ed.). Barcelona: Masson.
- [39] ROWICK, T., & ZAKRZEWSKA, J. (2006). A study of the discomalleolar ligament in the adult human. *Folia morphologica*, 65(2), 121–125.
- [40] SAPPEY, P. (1867). *Traite d'anatomie descriptive* (1st ed.). Paris: Acta Anat.
- [41] SATO, I., ARAI, H., IMURA, K., KAWAI, T., & YOSUE, T. (2008). Classifications of tunnel-like structure of human petrotympanic fissure by cone beam CT. *Surg Radiol Anat*, 30(4), 323–326.
- [42] SENCIMEN, M., YALCIN, B., DOĞAN, N., VAROL, A., OKÇU, K., OZAN, H., & AYDINTUĞ, Y. (2008). Anatomical and functional aspects of ligaments between

the malleus and the temporomandibular joint. *Int J Oral Maxillofac Surg*, 37(10), 943–947.

- [43] STANDRING, S. (2005). *Gray's anatomy: The anatomical basis of clinical practice* (39th ed.). Edinburgh: Elsevier.
- [44] TESTUT, L., & LATARJET, A. (1975). *Tratado de Anatomia Humana*. Barcelona: Salvat Editores.
- [45] TOLEDO FILHO, J., ZORZETTO, N., & NAVARRO, J. (1985). Structures and relationships of the anterior malleus ligament. *Anatomischer Anzeiger*, 158(1), 13–22.
- [46] WILLIAMS, P. (1995). *Gray's Anatomy*. London: Churchill Livingstone.
- [47] YUODELIS, R. (1966). The morphogenesis of the human temporomandibular joint and its associated structures. *J Dent Res*, 45(1), 182–191.

Narratives of Health Professionals Relating to Scarce Resources in an Urgency Service

Narrativas De Profissionais De Saúde Relativas A Recursos Escassos Em Um Serviço De Urgência

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Abstract— *This study aimed to analyze the narratives of health professionals working in a Emergency Care Unit that deal with decision making in situations of scarce resources. An exploratory research, of a qualitative nature, was carried out through a narrative interview technique with 25 professionals. Three categories emerged from the study: Decision making in the face of scarce resources; Ethical conflicts; Academic preparation for confrontation and the sentimental framework. Prioritization of patients is a reality in this health service. The prevalent problems are the scarcity of materials and medicines and the lack of human resources. The discourse preached the lack of ethical preparation of the academy for decision making. Most of the interviewees believe that they had little preparation to face the reality of the service. Some interviewees showed feelings of regret, impotence, insecurity, desire to abandon service, anguish and personal conflicts in the face of the wear and tear caused by the situation. It is necessary to invest in constant dialogues, health education and awareness-raising strategies in order to contribute to consensual actions that best subsidize decision-making in situations of scarce resources and that favor equitable health care in order to maximize benefits and reorient processes job.*

Keywords— *Emergency Care Unit, Health Professionals, Ethical conflicts.*

Resumo— *Este estudo objetivou analisar as narrativas de profissionais de saúde atuantes em uma Unidade de Pronto Atendimento que lidam com a tomada de decisão em situações de recursos escassos. Realizou-se uma pesquisa exploratória, de natureza qualitativa, através da técnica de entrevista narrativa com 25 profissionais. Do estudo emergiram três categorias: Tomada de decisão frente a escassez de recursos; Conflitos éticos; Preparo acadêmico para o enfrentamento e o arcabouço sentimental. A priorização de pacientes é uma realidade neste serviço de saúde. Os problemas prevalentes são a escassez de materiais e medicamentos e a falta de recursos humanos. Prevaleceu o discurso da falta de preparo ético da academia para com a tomada de decisão. A maioria dos entrevistados acredita que teve pouco preparo para enfrentar a*

realidade do serviço. Alguns entrevistados demonstraram sentimentos de pesar, impotência, insegurança, desejo de abandono do serviço, angústia e conflitos pessoais em face do desgaste causado pela situação. É necessário investir em constantes diálogos, educação em saúde e estratégias de sensibilização de forma a contribuir para ações consensuais que melhor subsidiem a tomada de decisão em situação de recursos escassos e que favoreçam o cuidar em saúde equânime de forma a maximizar benefícios e reorientar processos de trabalho.

Palavras-chave— *Unidade de Pronto Atendimento, Profissionais da Saúde, Conflitos éticos.*

I. INTRODUÇÃO

Nos cenários dos serviços de urgência e emergência existem situações rotineiras como a necessidade da microalocação de recursos escassos, em que se faz necessária a tomada de decisão que deve ser alicerçada por princípios bioéticos. Tal prática é protagonizada por médicos, enfermeiros e outros profissionais que lidam com a fragilidade que o cenário lhes impõe, uma vez que existe o risco iminente de morte do paciente^{9,10}.

No campo prático da saúde pública, a alocação de recursos tem sido um sério problema enfrentado, o que justifica reflexões norteadas pela Bioética neste contexto, que compreenda e envolva as excentricidades que possuem os países em desenvolvimento¹¹.

A microalocação de recursos está relacionada à discussão e análise das formas de seleção individualizada de pessoas que serão beneficiadas pelos serviços disponíveis, uma vez que estes são escassos. Para tanto, podemos citar como exemplos de recursos escassos: estrutura hospitalar insuficiente; falta de leitos; número insuficiente de profissionais; restrição de acesso a drogas e insumos de maior eficácia e eficiência e a equipamentos tecnológicos¹⁰⁻¹².

Por outro lado, destaca-se que nem sempre a abordagem ética se apresenta como tema de conhecimento suficiente para profissionais de saúde e tomadores de decisão. Parte-se da hipótese de que algumas decisões são originárias de discussões coletivas com participação da equipe, entretanto, concebê-las é extremamente desafiador, conflitante, estressante e causador de sofrimento¹⁰⁻¹³.

Este estudo teve por objetivo analisar as narrativas de profissionais de saúde atuantes em uma Unidade de Pronto Atendimento que lidam com a tomada de decisão em situações de recursos escassos.

A discussão sobre esta temática ainda é incipiente¹³ e o cenário atual vem sofrendo danosas imposições que comprometem a vivacidade do Sistema de Saúde vigente. Convive-se com restrição de investimentos em virtude da crise política-econômica, do subfinanciamento crônico e de políticas privatizantes¹⁴ contribuindo ainda mais para os desgastes dos serviços e atenção inadequada à saúde.

II. METODOLOGIA

Trata-se de uma pesquisa exploratória, de natureza qualitativa, utilizando por estratégia a técnica da narrativa que configura-se como um método não estruturado que possibilita aflorar histórias de vida dos entrevistados entremeadas ao contexto situacional¹⁵.

O estudo foi aprovado pelo Núcleo de Ensino, Pesquisa e Extensão da instituição coparticipante e pelo Comitê de Ética em Pesquisa da Universidade Federal de Minas Gerais, sob o número CAAE: 5421211600005149.

O cenário foi uma Unidade de Pronto Atendimento da cidade de Belo Horizonte, Minas Gerais, Brasil, tendo como participantes 10 enfermeiros e 15 médicos que atenderam aos seguintes critérios de inclusão: trabalhar na unidade há pelo menos um ano e exercer dentre suas funções laborais, a tomada de decisão no que se refere à microalocação em situação de recursos escassos.

A coleta de dados ocorreu entre os meses de junho a agosto de 2016, sendo a abordagem do entrevistador determinada pela solicitação “*relate sua experiência sobre a tomada de decisão em situações de recursos escassos no âmbito da microalocação*”.

As entrevistas, individuais, foram realizadas em local e horário pré-determinado pelos participantes, e com permissão prévia foram gravadas. Nenhum dos participantes desistiu durante este processo. Todos foram identificados pelas letras “TD” (Tomador de Decisão) acompanhadas de um número inteiro diferente. A amostra foi considerada satisfatória e a repetição de depoimentos com as mesmas características e informações caracterizou a saturação dos dados, quando se atingiu o total de 25 participantes.

Para a análise dos dados, operou-se com a diminuição do texto transcrito de forma gradativa, trabalhando-se com condensação de sentido e generalização, como proposto por Muylaert *et al*¹⁵ para a análise de entrevistas narrativas, emergindo as seguintes categorias: (1) *Tomada de decisão frente a escassez de recursos*; (2) *Conflitos éticos*; (3) *Preparo acadêmico para o enfrentamento e o arcação sentimental*.

Para traçar o perfil dos participantes da pesquisa, utilizou-se de um formulário com variáveis relativas ao

gênero, formação, idade, e tempo de atuação profissional, que foram preenchidos pelos mesmos no ato da abordagem.

III. RESULTADOS

Dos participantes 76% eram do sexo feminino, entre estes, 60% dos entrevistados atuavam como médicos e os outros 40% atuavam como enfermeiros. No que tange a idade, 12% dos participantes possuíam até 45 anos, no entanto a maior porção apresenta ter de 26 à 30 anos, representando 40% do volume total. Quanto ao tempo em que trabalhavam no estabelecimento de saúde, 56% dos entrevistados afirmam dispor de até 5 anos de atuação profissional; 40%, possuíam até 11 anos; e 4% relataram uma experiência superior a 12 anos.

Tomada de Decisão frente à escassez de recursos

Os discursos indicaram que a priorização de pacientes é uma realidade, sendo enfrentada levando-se em consideração critérios como idade, prognóstico e chances de sobrevivência.

“(…) a escolha passa, por exemplo, isso na minha opinião, nesse caso que eu tive, foi pela idade da paciente (…)” (TD19)

“A gente tenta priorizar mais jovem porque, né, tem uma vida toda pela frente, o idoso já tá chegando, dizemos assim, né, no fim da vida”. (TD14)

“O estado clínico do paciente. Paciente que tá mais grave, a idade do paciente e o tempo que o paciente tá aqui já”. (TD02)

“Olha, a gente vê quem tá mais grave e quem tem mais chance de sobreviver, então se eu tenho dois pacientes igualmente graves e eu só posso dar atenção a um”. (TD21)

Entretanto, existiram relatos em que não houve a necessidade de priorização de pacientes por possuir profissionais suficientes para o atendimento.

“Se for o caso eu chamo outro colega que tá lá na porta e tudo, pra eu não, né, priorizar um paciente em detrimento de outro, então assim eu não priorizo um paciente em detrimento de outro não.” (TD09)

“Quando a gente tem mais de um paciente grave, aqui e nas outras unidades que eu trabalho, a gente tem um colega que pode atender quando tem mais de um.” (TD22)

A priorização de paciente passou também por escolher aquele que seria encaminhado para internação quando o serviço de referência disponibiliza a vaga, já que as vagas disponíveis para internação são insuficientes no julgamento dos entrevistados.

“(…) já troquei uma vaga é...porque na minha opinião naquele momento o outro precisava muito mais.

Mas então eu fiz, né, teoricamente eu tirei de um pra colocar o outro né.” (TD07)

Houve relato sobre dificuldade em identificar até que ponto a adoção de determinadas práticas para a tomada de decisão foi considerada assertiva, isto, justificado pelos participantes pela falta de *feedback* e do treinamento em serviço.

“É sentar mesmo com ele, falar assim, olha que tipo de conflito que você já vivenciou? E qual foi a sua tomada de decisão? Olha se você tivesse feito isso aqui seria melhor do que essa decisão sua tomada (...) Eu acho que antes de tudo... a educação continuada ela deveria existir.” (TD23)

Sobre a participação de outros membros da equipe na tomada de decisão prevaleceu à tomada de decisão conjunta e uma entrevistada remeteu à família como ponto de apoio nesse processo.

“Eu sempre costumo recorrer aos médicos, aos meus colegas e quem tem mais preparo do que eu”. (TD03)

“(…) quando é algum paciente crítico na unidade, há um consenso entre a equipe né e entre o médico, enfermeiro, família”. (TD24)

A perspectiva de continuidade do atendimento em outros níveis de atenção também foi considerada como um fator para tomarem decisão. Além de ser notório o relato da problemática frente à existência ou não de vaga, principalmente quanto à transferência para os serviços de referência.

“A gente faz contato e não consegue transferir os pacientes, né, então assim infelizmente a gente acaba ficando com esse paciente e muitas vezes até o óbito...” (TD07)

“O paciente fica aqui séculos, paciente que excede a nossa complexidade de atuação e o paciente fica aqui porque muitas vezes a gente não consegue transferir, entendeu!?” (TD09)

“(…)eu selecionei aquele que naquela situação teria mais condições de continuar, que eu teria condições de conseguir um CTI pra ele, que eu teria condições de uma transferência, de um tratamento e ele sair daquela situação e o outro infelizmente eu tive que tratar com que eu tinha pra oferecer, e infelizmente ele veio a falecer” (TD11)

As narrativas sobre a experiência vivida em situação de recursos escassos convergiram com relação aos principais tipos de escassez: equipamentos e estrutura, recursos humanos e medicamentos.

“acho que a nossa pior dificuldade é o recurso humano porque esse não tem como você reinventar, não tem como você fazer aparecer um funcionário” (TD24)

“simplesmente cê não tem o recurso, cê não tem o leito pro paciente, cê não tem medicação... então assim, é difícil” (TD19)

Conflitos éticos

Foi evidente a divergência, apreensão e dificuldade dos entrevistados em relatarem suas experiências no que tange aos aspectos éticos relacionados à prática da tomada de decisão e priorização de pessoas. Algumas narrativas estiveram imbuídas nos problemas que emergem da escolha daquele que será preterido em virtude da escassez do recurso:

“Fica na nossa mão um papel de julgar quem deve e não deve... Quem deve ganhar e quem não deve” (TD12)

“Acho que escolher quem vai sobreviver, pra mim é absurdo (risos) escolher quem vai seguir é uma coisa que é anti-ético, infelizmente é uma realidade...” (TD10)

Alguns relatos se fundamentaram em critérios clínicos e objetivos para responder às questões éticas envolvidas na priorização de pacientes. Os entrevistados consideraram que atitudes não éticas estariam relacionadas à escolha baseada em aspectos socioeconômicos.

“Eu acho que a questão ética ela ficaria mais evidente se você escolhesse esse paciente por um critério subjetivo, se você escolher aquele paciente por questão econômica, por raça, alguma coisa desse tipo, eu acho que quando cê está usando um critério de gravidade, cê está usando o critério médico, entendeu!?” (TD11)

“(...) a gente tem a ética com paciente, né, a gente não discrimina ele por nenhum motivo não (...). Eu vou ver o que ele é, o que é o ser humano, o que que ele tá precisando (...) o que ele é ou deixa de ser, isso não faz, num influencia para escolha de qual paciente vai ter a prioridade na assistência devido a escassez de recurso não.” (TD14)

Outros discursos mostraram uma visão “minimalista” em que a priorização de paciente estaria relacionada ao processo de Acolhimento com Classificação de Risco.

“A gente num tem uma escolha ética ou não, não tem uma visão ética ou não, todo paciente recebe o atendimento que tem na UPA, no entanto, de acordo com protocolo de Manchester” (TD23)

“Partindo do pressuposto que eles já foram classificados por uma questão de risco, eu acho que eticamente a gente tem obrigação de atender nessa evolução, né” (TD22)

Prevaleceu o discurso da falta de conhecimento ético oriundo da academia para a tomada de decisão e priorização de pessoas.

“Não, a gente não vê isso na teoria, a gente aprende só na prática depois que você pega né... que você começa a trabalhar, que você começa a ver, enfrentar as dificuldades (...) a gente não tem essa preparação na graduação, muito menos na pós-graduação, é muita teoria e pouco né... pouca prática” (TD24)

“Não! Acho que é mais com o dia-a-dia que a gente vai adquirindo esse preparo mesmo. Eu acho que na minha graduação que foi o básico” (TD01)

“Chegar aqui e vivenciar uma outra realidade é um pouco complicado, eu não tive preparo pra isso” (TD10)

Preparo acadêmico para o enfrentamento e o arcabouço sentimental

A percepção dos entrevistados sobre o preparo que possuem para a tomada de decisão envolvendo a sobrevida de pacientes em meio a recursos escassos permite entender a fragilidade no que tange o preparo profissional, sobretudo, no que diz respeito ao preparo acadêmico sobre a questão.

“(silêncio) Olha, eu acho que a tomada de decisão, eu, eu acho que... eu tive... eu tive capacitação para isso (...) mas eu acho que eu não fui capacitada com a priorização de paciente. Eu acho que eu fui capacitada para uma realidade que eu não encontrei, eu não me deparei, eu acho que a faculdade é excelente só que ela tá um pouco, as vezes, longe da nossa realidade (...)” (TD23)

“(silêncio) apanhando todo dia, aí cê vai aprendendo a lidar com isso (...) por mais que você forme em uma boa faculdade (...) você ainda sai despreparado para enfrentar muita coisa, você tem um conhecimento teórico mas a prática ainda... ce aprende demais aqui trabalhando.” (TD11)

Algumas falas remetem a perplexidade que os profissionais carregam em virtude do cenário em que trabalham.

“(...) eu simplesmente não consigo não deixar de me importar, isso para mim é o pior. Então, assim, psicologicamente falando, que o médico e enfermeiro que tá nessa situação, a gente sofre com isso, então preparo nenhum, eu saio e não aceito.” (TD19)

“Eu acho que na graduação nós deveríamos assim, (...) ser mais preparados para isso (...) a saúde não é uma receita de bolo né, você não sai com as dosagens tudo bonitinho que vai dar certo mas poderíamos trabalhar mais, investir isso mais nos alunos”

para que eles venham depois para o mercado de trabalho um pouco mais preparados.” (TD16)

Todos os participantes do estudo relataram espontaneamente sobre seus anseios e sentimentos frente ao tomada de decisão em situação de escassez de recursos, mesmo não interpelados sobre esta questão. Alguns enfatizaram que vivenciam sentimentos de pesar, impotência e insegurança.

“O que mais me pesa, o que mais fico chateada é de não poder fazer o melhor, você saber, ter uma bagagem, pede ajuda, lê nos livros, se capacita, mas você chega no local de serviço que não tem... não tem o que você fazer...” (TD19)

“Você fica insegura com receio de tá pensando se realmente você tomou a decisão certa (...) se a posição que você teve foi de forma adequada, então a gente sempre fica com esse receio, a gente tenta fazer o melhor mas não sabe se foi a melhor decisão tomada.” (TD03)

Os entrevistados expressaram também o desejo de abandono do serviço, angústia e conflitos pessoais em face do desgaste causado pela situação.

“Vivencio diariamente conflitos pessoais principalmente (risos) isso pra mim é um grande peso, eu já cheguei a abandonar algumas vezes (...) eu cheguei a pedir para sair da unidade porque eu não consegui lidar com essa seleção.” (TD10)

“Vou embora do plantão, às vezes passa, a gente brinca, passa a bomba mas eu vou embora pensando naquilo, é muito frustrante (...) eu sempre vou embora me sentindo muito mal e a angústia só aumenta.” (TD19)

Entretanto houve também profissionais que referiram tranquilidade, satisfação e sensação de dever cumprido nessa jornada, embora também tenha existido sentimento de culpa em momentos passados.

“Ah, eu fico tranquilo, mas assim, quando você tem essa decisão nesse sentido de ter em detrimento de um priorizar o outro, é ruim, né (...) eu não me sinto culpado por isso não... já me senti, a gente sente desconforto.” (TD05)

“É difícil, mas é bom, satisfatório também você vê que a sua tomada de decisão beneficiou o paciente.” (TD14)

“Eu nunca chego em casa e coloco a cabeça no travesseiro e penso assim podia ter feito mais, sabe, eu acho que eu sempre faço o que eu posso, o que tá no meu alcance dentro do que eu tenho.” (TD17)

As falas convergiram de modo geral para o desconforto sobre a situação vivida e desejo de que as decisões fossem até mesmo feitas por outros colegas de trabalho, gerando sensações de maior conforto e até mesmo de condescendência.

“tem hora que seria melhor a gente passar a responsabilidade pro outro, né... É muito ruim cê chegar pra uma pessoa e falar que cê não tem mais o que fazer, né (...) eu me sinto muitas vezes muito desconfortável, né, porque eu preferia que outra pessoa tivesse se responsabilizando por aquilo.” (TD07)

“Eu tomo as decisões mas não gosto, várias vezes eu converso com a equipe com quem tá comigo pra que não seja uma decisão única, não gosto de assumir sozinha alguns pontos não.” (TD10)

IV. DISCUSSÃO

Neste estudo, os entrevistados não expressaram auto-avaliações positivas quando relataram suas experiências no que concerne a tomada de decisão. A culpabilização e a preferência que outros decidam por eles, abrindo mão da tomada de decisão autônoma, foram marcantes nos depoimentos. A tomada de decisão em situação de recursos escassos parece resultar em conflitos éticos, levando a uma obrigação moral de disponibilizar recursos a qualquer custo. Este achado diverge do estudo realizado com médicos residentes na Catalunha em que os resultados demonstraram que estes profissionais avaliam positivamente suas experiências frente e tomada de decisão em serviços de urgência¹⁶.

Nesta perspectiva, a Bioética pode ser utilizada como um instrumento norteador por ser capaz de respaldar os envolvidos sobre os valores que prevalecerão na orientação e na justa tomada de decisão sobre as prioridades das necessidades de saúde a serem atendidas, bem como, aos limites a serem estabelecidos em situação de escassez de recursos¹⁷.

Cabe destacar a importância de a Bioética estar em consonância ao contexto em que está inserida de forma a melhor subsidiar as tomadas de decisão para os problemas sérios com relação à alocação de recursos no setor saúde¹⁸.

Surgem com o passar do tempo, formulações acerca da Bioética que melhor compreenderia as necessidades de países em desenvolvimento e que não estão exatamente relacionadas à Bioética proposta por *Beauchamp e Childress*¹⁸ que se pauta no principialismo, utilitarismo, autonomia e justiça. A realidade distinta desses países faz com que o enfoque seja diferente, imergindo a Bioética em um cenário de pobreza, desigualdade e exclusão social, o que evidencia a priorização de pessoas consideradas mais vulneráveis¹⁹.

Os participantes desta pesquisa, em sua maioria, referem à falta de conhecimento bioético desde a formação acadêmica, o que contribui para o estabelecimento de uma conexão frágil entre teoria e a prática profissional. A abordagem minimalista das

questões éticas tratadas no ambiente formativo não estimula a reflexão no campo moral, subjugando-a apenas à interpretação dos códigos de ética profissional²⁰. Apesar de na prática esperar-se tais responsabilidades, os entrevistados afirmaram que a academia não lhes preparou para esta tomada de decisão do ponto de vista ético.

Neste contexto, entendemos que se faz necessário um olhar sobre o ensino da bioética nos cursos de graduação da área da saúde que deve ser uma realidade e considerar a variedade de problemas que tem insurgido neste campo, tal qual como a necessidade de escolher pessoas para receber atendimentos em face da escassez de recursos.

Este paradoxo entre a dificuldade de entender e reconhecer a Bioética como instrumento para a tomada de decisão encontrada nesta pesquisa, corrobora com outros estudos que referem desconforto e dúvidas de tomadores de decisão sobre suas percepções no que diz respeito a questões de cunho moral e ético^{10-22; 23; 24}.

Quando relacionada à priorização de pacientes, a análise dos dados deste estudo nos permitiu confirmar que a tomada de decisão está ancorada em aspectos técnicos como gravidade, emergência, prognóstico, além, de julgamentos e dilemas morais dos atores envolvidos^{12,20}.

Os desafios da escolha passam também por considerar a probabilidade de resultados favoráveis e no contexto apresentado por este estudo, deve estar alicerçada na relação profissional-paciente. Ou seja, consideram a influência de outros atores que estão diretamente ou indiretamente envolvidos na situação, sejam eles os demais profissionais da equipe, a família e outras pessoas ligadas ao paciente^{25,20}.

A interpretação das narrativas permite entender que a tomada de decisão considera o compartilhamento de casos entre a equipe, passando pelo aconselhamento e orientações dos mais experientes e pelas discussões em conjunto. Não foi possível, contudo, identificar se o compartilhamento da decisão ocorre apenas por membros da mesma classe profissional ou de forma multiprofissional.

O compartilhamento de responsabilidades e a observância das considerações moralmente relevantes podem minimizar o sentimento de incerteza, já que nenhum princípio isolado é capaz de dar conta da priorização dos recursos da melhor forma possível^{10,20}.

O parâmetro idade foi apontado pelos participantes deste estudo como um critério aceito e utilizado para priorização de pacientes em situações de recursos escassos. Conclusões adversas foram obtidas por outro pesquisador, segundo estudo de Fortes¹⁷ realizado com bioeticistas, foi desfavorável ao racionamento de

cuidados de saúde baseado em critérios relativos à faixa etária. Entendemos ser pertinente mencionar e refletir sobre o fato de aceitar a idade como um critério de alocação de recursos em situação de escassez, posição essa discutível para ser considerada se levadas em conta às profundas modificações na estrutura etária das populações ocorridas desde o século XX.

A tomada de decisão como intrínseco a atuação profissional, muitas vezes ocorre em situações de conflitos, pois se trata de escolhas em situações de vulnerabilidade em meio a princípios divergentes²⁰. Concomitantemente, a ansiedade e sofrimento do paciente e da família são fatores que podem pressionar e fragilizar a prática da assistência, fato que reafirma a necessidade do substrato ético e moral para enfrentamento desta realidade²⁶.

Finalmente, alguns depoimentos evidenciaram a questão da existência de um número insuficiente de recursos humanos, que resulta em sobrecarga de trabalho; além da falta de materiais, que se traduz na necessidade de improvisos ou assistência inadequada. Fatores estes que contribuem para a insatisfação e desmotivação dos trabalhadores, além de fragilizar a prestação de serviços e a segurança do paciente. Vale destacar a ponderação de Oliveira²⁷ *et. al.* que concluiu que o conhecimento tácito, a experiência, os valores e as habilidades em desenvolver ações que priorizem a segurança do paciente constituem um tipo diferente de evidência, a qual tem uma forte influência na tomada de decisão.

Percebe-se nos discursos de alguns profissionais sentimentos de pesar, impotência e insegurança que requerem atenção no ambiente de trabalho, uma vez que podem contribuir para a exaustão e a despersonalização que passam a fazer parte da situação laboral nestes cenários. O impacto disso faz tornar as relações inviabilizadas e o trabalho como sem sentido na vida²⁸⁻³⁰.

Todavia, foram ainda evidenciados muitos discursos relativos à satisfação e sensação de dever cumprido frente à tomada de decisão na eminência de recursos escassos. Portanto, é de considerável relevância investir nestes profissionais, permitindo sua participação nos processos de análise permanente da tomada de decisão frente a recursos insuficientes, para continuarem identificando os riscos e incorporando práticas seguras e baseadas em evidência na instituição.

Considera-se a realização da investigação em uma única UPA, uma limitação deste estudo, pois pode não representar a realidade de outras unidades. Entretanto buscou-se aprofundar o significado que emergiu sobre a questão de pesquisa o que ratifica sua contribuição científica, frente à incipiência de outros estudos semelhantes.

V. CONSIDERAÇÕES FINAIS

Os resultados da pesquisa evidenciam que entre os profissionais pesquisados o pluralismo de valores morais é manifesto na questão da priorização ou estabelecimento de limites para utilização de recursos escassos no sistema público de saúde. Da diversidade de perspectivas e opiniões se pode inferir que as dificuldades do mundo contemporâneo em decidir moralmente sobre a questão parecem ser característica marcante de nossa época.

Dessa forma, é necessário investir em constantes diálogos, educação em saúde e estratégias de sensibilização de forma a contribuir para ações consensuais que melhor subsidiem a tomada de decisão em situação de recursos escassos e que favoreçam o cuidar em saúde equânime de forma a maximizar benefícios e reorientar processos de trabalho.

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REFERÊNCIAS

- [1] Brasil. Ministério do Planejamento. UPA - Unidade De Pronto Atendimento. [publicação online] [201-] Disponível em: <http://www.pac.gov.br/comunidade-cidada/upa-unidade-de-pronto-atendimento>.
- [2] Brasil. Ministério da Saúde. Núcleos de Economia da Saúde: orientações para implantação [publicação online]. Brasília; 2012 [cited 2017 Feb 07]. Disponível em: http://bvsms.saude.gov.br/bvs/publicacoes/gestao_economia_saude_v1_nucleos_implantacao.pdf
- [3] Kuate Defo B. Demographic, epidemiological, and health transitions: are they relevant to population health patterns in Africa? *Global Health Action* [periódico na Internet] 2014 [acessado 2017 Ago 3];7(10). Disponível em: <http://www.tandfonline.com/doi/full/10.3402/gha.v7.22443>
- [4] Brasil. Ministério da Saúde. Portaria nº 1.600, de 7 de julho de 2011. Reformula a Política Nacional de Atenção às Urgências e institui a Rede de Atenção às Urgências no Sistema Único de Saúde (SUS). Brasília, DF, 07 jul 2011. Disponível em: http://bvsms.saude.gov.br/bvs/saudelegis/gm/2011/prt1600_07_07_2011.html
- [5] Brasil. Ministério da Saúde. Sem Título. [publicação online]. Brasília; 2014 [acessado 2017 Fev 07]. Disponível em: <http://portalsaude.saude.gov.br/index.php/o-ministerio/principal/secretarias/454-sas-raiz/dab/upa/11-upa/9667-documento-prioritario>.
- [6] Brasil. Conselho Nacional de Secretários de Saúde. A Atenção Primária e as Redes de Atenção à Saúde. [publicação online]. Brasília; 2015 [acessado 2017 mar 03]. Disponível em: <http://www.conass.org.br/biblioteca/pdf/A-Atencao-Primaria-e-as-Redes-de-Atencao-a-Saude.pdf>
- [7] Erdmann AL, Andrade SR, Mello ALSF, Drago LC. Secondary Health Care: best practices in the health services network. *Rev Latino-Am Enfermagem* [periódico na Internet] 2013 Fev [acessado 2017 Jun 5]; 21(spe). Disponível em: <http://www.scielo.br/pdf/rlae/v21nspe/17.pdf>
- [8] Konder MT, O'Dwyer G. As Unidades de Pronto-Atendimento na Política Nacional de Atenção às Urgências. *Physis* [periódico na Internet] 2015 Jun [acessado 2017 Ago 07];25(2). Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-73312015000200525&lng=pt.
- [9] Silva KR, Mello DS. Recursos Escassos em Serviços de Urgência e Emergência e a Tomada de Decisão: Revisão bibliográfica. Simpósio Direito e Saúde – Diálogos Interdisciplinares Latinoamericanos; 2015; Santiago, Chile.
- [10] Vasconcellos MM. *A necessidade de priorizar o atendimento à pacientes: análise Bioética dos argumentos utilizados por médicos na aplicação de recursos limitados na área da saúde*. [dissertação]. Rio de Janeiro: Escola Nacional de Saúde Pública Sérgio Arouca/ Fundação Oswaldo Cruz, 2010.
- [11] Rocha RO. *Bioética e Alocação de Recursos em Saúde: Reflexões sobre o Compartilhamento Democrático das Tecnologias Médicas Avançadas*. [dissertação]. Salvador: Universidade Federal da Bahia; 2013.
- [12] Freitas EEC, Schramm FR. A moralidade da alocação de recursos no cuidado de idosos no centro de tratamento intensivo. *Rev Bras Ter Intensiva* [periódico na Internet] 2009 [acessado 2017 Mar 03] 21(4). Disponível em: <http://www.rbti.org.br/exportar-pdf/v21n4a14.pdf>
- [13] Silva KR, Mello DS, Ribeiro RM, Roquete FF. Tomada de Decisão em Situação de Recursos Escassos: uma discussão bioética. *Simpósio de Excelência em Gestão e Tecnologia*; 2015; Resende, Rio de Janeiro.
- [14] Reis AAC, Sóter APM, Furtado LAC, Pereira SSS. Everything to fear: funding, public-private relations, and the future of SUS. *Saúde debate* [periódico na Internet] 2016 Dez [acessado 2017 Ago 31] 40(spe). Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-11042016000500122&lng=en.
- [15] Muylaert CJ, Sarubbi Jr V, Gallo PR, Rolim Neto ML, Reis AOA. Narrative interviews: an important resource in qualitative research. *Rev. esc. enferm. USP* [periódico na

- Internet]. 2014 Dez [acessado 2017 Fev 01]; 48(spe2). Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0080-62342014000800184&lng=en.
- [16] Coll-Vinent B, Carreño A, Morales X, Cerón A, Gutiérrez EC, Surís X. Opinión de los médicos residentes de los hospitales catalanes sobre la formación en urgencias. *Emergencias* [periódico na Internet] 2015 [acessado 2017 Jun 5]; 27(4). Disponível em: http://emergencias.portalsemes.org/descargar/opinin-de-los-mdicos-residentes-de-los-hospitales-catalanes-sobre-la-formacin-en-urgencias/force_download/
- [17] Fortes PAC. Bioeticistas e a priorização de recursos de saúde no sistema público de saúde brasileiro. *Revista Bioética* [periódico na Internet] 2010 [acessado 2017 Mar 04]; 18(2). Disponível em: http://revistabioetica.cfm.org.br/index.php/revista_bioetica/article/download/573/545
- [18] Beauchamp T L, Childress, J F. *Princípios de Ética Biomédica*. São Paulo: Loyola, 2002.
- [19] Pessini L, Barchifontaine CP. *Problemas atuais de bioética*. 8. ed. São Paulo: Loyola, 2007.
- [20] Oliveira SCGF. *Protocolos e diretrizes clínicas: Uma análise moral na tomada de decisão* [dissertação]. Rio de Janeiro: Escola Nacional de Saúde Pública - Fundação Oswaldo Cruz; 2014.
- [21] Leite DAA, Pessalacia JDR, Braga PP, Rates CMP, Azevedo C, Zoboli ELCP. Uso de la casuística en el proceso de enseñanza-aprendizaje de bioética en la salud. *Revista Bioética* [periódico na Internet] 2017 [acessado 2017 Set 04]; 25(1). Disponível em: http://revistabioetica.cfm.org.br/index.php/revista_bioetica/article/viewFile/1032/1604
- [22] Belli L, Boden MT, Quadrelli S, Somers ME ¿Qué hacer cuando no sabemos qué hacer? *Revista Americana de Medicina Respiratoria* [periódico na Internet] 2015 [acessado 2017 Mar 04]; 15(4). Disponível em: <http://www.redalyc.org/pdf/3821/382143170011.pdf>
- [23] Saraiva AMP. Acesso à tecnologia biomédica: perspectiva bioética dos enfermeiros portugueses. *Revista Bioética* [periódico na Internet] 2014 [acessado 2017 mar 04]; 22(1). Disponível em: <http://www.scielo.br/pdf/bioet/v22n1/a18v22n1.pdf>
- [24] Abreu CBB. *Questões éticas reconhecidas por profissionais de uma equipe de Cuidados Paliativos*. [tese]. São Paulo: Faculdade de Saúde Pública- Universidade de São Paulo; 2014.
- [25] Montezeli J, Peres A, Bernardino E. Nurse Management Skills Required At An Emergency Care Unit. *J res: fundam care online* [periódico na Internet] 2013 Mai [acessado 2017 Sep 7]; 5(3). Disponível em: <http://www.seer.unirio.br/index.php/cuidadofundamental/article/view/2019>
- López-Martín S, Galera-Martin C, Guerra-Tapia A. Ethics in Dermatology: Toward a New Paradigm. *Actas Dermosifiliogr* [periódico na Internet] 2013 [acessado 2017 Sep 28]; 104(6). Disponível em: <http://www.actasdermo.org/en/dermatologia-etica-el-nuevo-paradigma/articulo/S1578219013001170/>
- [26] Oliveira RM, Leitão IMTA, Silva LMS, Figueiredo SV, Sampaio RL, Gondim MM. Estratégias para promover segurança do paciente: da identificação dos riscos às práticas baseadas em evidências. *Escola Anna Nery Revista de Enfermagem* 18(1) Jan-Mar 2014. Disponível em: <http://www.scielo.br/pdf/ean/v18n1/1414-8145-ean-18-01-0122.pdf>
- [27] Ribeiro CDM, Rego S. Bioética clínica: contribuições para a tomada de decisões em unidades de terapia intensiva neonatais. *Ciência & Saúde Coletiva* [periódico na Internet] 2008 [acessado 2017 mar 04]; 13(spe) Disponível em: http://www.scielo.br/scielo.php?pid=S1413-81232008000900028&script=sci_abstract
- [28] Oliveira EB, Pinel JS, Gonçalves JBA, Diniz DB. Nursing work in hospital emergency units – psychosocial risks: a descriptive study. *Online braz j nurs* [periódico na Internet] 2013 Mar [acessado 2017 Sept 7]; 12(1). Disponível em: <http://www.objnursing.uff.br/index.php/nursing/article/view/4046>.
- [29] Batista JBV, Carlotto MS, Oliveira MN, Zaccara AAL; Barros EO, Duarte MSC. Transtornos mentais em professores universitários: estudo em um serviço de perícia médica. *Rev. pesqui. cuid. fundam.*, [periódico na Internet] 2016 [acessado 2017 Sep 28]; 8(2). Disponível em: http://www.seer.unirio.br/index.php/cuidadofundamental/article/download/5009/pdf_1914
- [30] Casarolli ACG, Eberhardt TD, Nicola AL, Fernandes LM. Nível de complexidade assistencial e dimensionamento de enfermagem no Pronto-Socorro de um hospital público. *Revista de Enfermagem da UFSM* [periódico na Internet] 2015 Jul [acessado 2017 Jun 15]; 5(2). Disponível em: <https://periodicos.ufsm.br/reufsm/article/view/16811>

Uma aplicação colaborativa de incentivo a doação de sangue

A collaborative application to encourage blood donation

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Abstract— Objective: Implementing a collaborative system that promotes the encouragement and support of blood donation. Permitting specific patient blood donation requests, disseminating general outreach campaigns, reviewing site information for donation, as well as keeping users up-to-date on blood stock levels of blood centers and disclose the procedures necessary to become donor blood. **Method:** A qualitative survey was carried out of the main tools with possible related proposals to serve the region of Cajazeiras, Paraíba, Brazil. **Results:** It was identified the existence of possible tools to encompass the region of the study using them to know the needs and definition of the scope of the collaborative system proposing new approaches in the development for implantation in the Hemonúcleo of the city of Cajazeiras. **Conclusion:** The development of the collaborative system contemplated a series of functionalities to join blood centers and candidates to blood donation to better maintain the life of several patients.

Keywords— Blood donation; Collaborative system; Blood centers.

Resumo— Objetivo: Implementar um sistema colaborativo que promova o incentivo e apoio a doação de sangue. Permitindo realizar pedidos de doação de sangue para paciente específico, divulgar campanhas de abrangência geral, consultar informações de locais para doação, assim como, manter os usuários atualizados sobre os níveis de estoques de sangue dos hemocentros e divulgar os procedimentos necessários para se tornar doador de sangue. **Método:** Foi realizado um levantamento qualitativo das principais ferramentas com propostas relacionadas possíveis de atender a região de Cajazeiras, Paraíba, Brasil. **Resultados:** Identificou-se a existência de ferramentas possíveis de atender a região do estudo utilizando-as para conhecer as necessidades e definição do escopo do sistema colaborativo propondo novas abordagens no desenvolvimento para implantação no Hemonúcleo da cidade de Cajazeiras. **Conclusão:** O desenvolvimento do sistema colaborativo contemplou uma série de funcionalidades para unir hemocentros e candidatos à doação de sangue para melhor manutenção da vida de inúmeros pacientes.

Descritores— Doação de Sangue; Sistema colaborativo; Hemocentros.

I. INTRODUÇÃO

No Brasil cerca de 3,5 milhões de pessoas necessitam da realização de transfusão de sangue por ano⁽¹⁾. Diante disso, é importante traçar mecanismos voltados à prevenção da vida de inúmeros pacientes que dependem de transfusão de sangue por meio da manutenção dos estoques sanguíneos.

Sendo assim, os hemocentros se deparam com a necessidade de adotar medidas que influenciem novos doadores a se prontificarem espontaneamente para doação de sangue, uma vez que a Constituição Federal de 1988, vigente atualmente, em seu §4º do Art. 199 que discorre sobre a coleta, processamento, estocagem, distribuição e aplicação do sangue, coloca em estado de proibição qualquer tipo de comercialização do sangue e seus hemoderivados⁽²⁾.

Mediante o estado de proibição, o governo aplica e disponibiliza recursos para a realização de campanhas de utilidade pública, visando à manutenção e o abastecimento dos estoques sanguíneos que, tais recursos proporcionaram um gasto de R\$ 85,4 milhões de todo o orçamento para publicidades do Governo Federal em 2015⁽³⁾.

Os resultados destes gastos deveriam ser colhidos sucessivamente nos anos seguintes, construindo uma conscientização para surgirem sempre novas doações. No entanto, de acordo com os resultados dos dados coletados nos anos de 2016 e 2017 e divulgados no Dia Mundial do Doador de Sangue, celebrado em 14 de junho de 2017, no Hemocentro de Brasília (FHB)⁽⁴⁾, o percentual de doadores de 1,8% da população brasileira, mesmo estando dentro do indicado pela Organização Mundial da Saúde (OMS) ainda não era o ideal para o Brasil⁽¹⁾. O indicado é que a taxa de doações de sangue sempre caminhe afrente das necessidades de transfusões sanguíneas, já que o sangue e hemoderivados são fundamentais para a permanência da vida de pacientes. Para que ocorram melhorias e esse processo não se inverta é de extrema importância acolher iniciativas que visem atrair novos doadores, levando ao conhecimento de todos aqueles com condições favoráveis a importância de doar sangue.

A aplicação desenvolvida neste estudo permite compartilhar as motivações para se tornar doador de sangue por meio de pedidos de doação para pacientes específicos e de campanhas de abrangência geral. Permite também, consultar informações sobre os locais onde possa realizar doação de sangue e melhor se informar sobre o passo-a-passo de triagem e coleta do sangue, assim como, manter-se atualizado e informado sobre os níveis dos estoques sanguíneos em dado hemocentro/hemonúcleo. Além disso, recolher informações dos candidatos à doação, e disponibilizar para os administradores do hemocentro/hemonúcleo um mapa para auxiliar a tomada de decisões na elaboração das campanhas de cativação de novos doadores, conforme a necessidade sanguínea.

A aplicação pode ser utilizada para, por exemplo, a partir dos níveis de estoques de determinado tipo sanguíneo estarem baixo saber em quais regiões de uma cidade se concentra mais candidatos à doação de sangue do tipo necessário, ajudando assim, na aplicação e implementação da Política Nacional de Promoção da Doação Voluntária de Sangue principalmente na região de Cajazeiras, Paraíba, Brasil.

II. MÉTODOS

A realização do trabalho iniciou-se por meio de um estudo para analisar os critérios definidos pela legislação brasileira possível de serem utilizados para atrair candidatos para realização de novas doações de sangue. Conduziu-se também um estudo qualitativo com o propósito de relacionar os sistemas com propostas parecidas possíveis de serem utilizados na região de Cajazeiras do estado da Paraíba, para assim entender a viabilidade do desenvolvimento do sistema colaborativo deste trabalho, definindo o escopo e propondo novas funcionalidades.

Adotando a metodologia ágil *Scrum* como abordagem para o gerenciamento do projeto do *software* dividiu-se a realização do sistema, seguindo um fluxo das seguintes etapas:

- a) Conceituação da solução proposta: que visou entender as problemáticas e as possíveis soluções;
- b) Levantamento de requisitos: que possibilitou listar os requisitos com a finalidade de documentar todas as funcionalidades;
- c) Visão geral dos requisitos: em que foi feita um modelagem que ajuda na comunicação e interpretação dos requisitos;
- d) Projetos arquiteturais do sistema e aplicativo: definição da arquitetura, a separação em camadas e tecnologias a serem utilizadas para o desenvolvimento;
- e) Implementação das funcionalidades: desenvolvimento em si do sistema colaborativo (Mútuo Sanguíneo);
- f) Versionamento e validação: separação das implementações dos requisitos levantados, validada cada etapa junto ao Hemonúcleo da cidade de Cajazeiras no estado da Paraíba.
- g) Comparativo com ferramentas existentes.

Para validação das implementações das funcionalidades foi elaborado um questionário de aceitação, possibilitando aos interessados no desenvolvimento do sistema indicar o nível de satisfação quanto às funcionalidades implementadas e confirmar o posicionamento para cada implementação quanto ao grau atendimento se Excelente, Bom, Regular, Ruim ou Péssima.

III. RESULTADOS E DISCUSSÃO

Proporcionar um ambiente colaborativo, dotado das condições necessárias, que leve os candidatos a se decidirem voluntariamente a realizarem doações de sangue, não é tão simples. Para Massuchetto apud Maxim⁽⁵⁾ a tomada de decisão é uma habilidade complexa, mas que pode ser desenvolvida por meio de assistência e orientação.

Pensando assim, existem sistemas computacionais que conseguem fornecer informações fundamentais para tomada de decisões. Os *softwares* colaborativos de apoio coletivo à tomada de decisão é exemplo disso. Esta é uma classe de sistemas usados para ajudar às pessoas no exercício de atividades e trabalhos em conjuntos⁽⁶⁾. A abordagem deste autor caminha em encontro a etimologia do termo colaboração, que conforme Rios et al.⁽⁷⁾ (apud HOUAISS; VILLAR, 2009) significa trabalhar em comum acordo, ou seja, em coordenação harmônica de ações, diferentemente da cooperação que é trabalhar com outros sem a existência do consenso.

Para Rios et al.⁽⁷⁾ (apud FUKS et al., 2011) os sistemas colaborativos devem permitir a comunicação sem a dependência de tempo e espaço proporcionando condições para que grupos com objetivos comuns possam interagir.

Desta forma, Rios et al.⁽⁷⁾ (apud FUKS et al., 2011 apud ELLIS, et al., 1991) apresentam o modelo 3C, baseando-se na concepção de que para os membros de um grupo colaborarem se faz necessário:

- a) Comunicação: suporte a integração fácil e rápida dos grupos, pelo recebimento e envio de informações solicitações e instruções;
- b) Coordenação: permite uma sequência de tarefas de forma a buscarem um objetivo comum;
- c) Cooperação: proporcionando a realização do trabalho em conjunto, possibilitando unir experiências e habilidades.

Neste sentido temos a construção do Mútuo Sanguíneo pautando-se na visão dos processos decisórios e na análise das informações fornecidas de forma colaborativa pelos usuários para proporcionar apoio aos hemocentros/hemnúcleos na identificação das necessidades de trabalhar campanhas e ações na implantação da política de incentivo e apoio a doação de sangue. E com isso auxiliar no exercício de atrair novos candidatos para a prática da doação de sangue.

O desenvolvimento de *software* precisa ser apoiado na qualidade. A qualidade é um item preponderante para o sucesso de um software, estando ela ligada ao atendimento dos requisitos⁽⁸⁾. Para a construção de um sistema com foco na qualidade se faz necessário à adoção de metodologias, ou seja, fazer uso de abordagens tidas como práticas já firmadas no desenvolvimento de *software*⁽⁸⁾. Sendo assim, o processo de desenvolvimento *Scrum* foi usado para gerenciar o projeto de *software*, adequando-o ao contexto do sistema colaborativo o qual este trabalho está inserido.

O *Scrum* é uma metodologia ágil usada para gerenciar o desenvolvimento de projetos complexos desde o início de 1990 que tem como prerrogativa não resultar de um processo ou uma técnica rígida e definitiva para construção de produtos, mas sim, ser uma estrutura dentro da qual cada um pode empregar vários processos ou técnicas⁽⁹⁾. Essa metodologia enfatiza o uso de um conjunto de padrões de processos de *software* que provaram serem eficazes para projetos com prazos de entrega apertados, requisitos mutáveis e críticos de negócio⁽⁸⁾.

Nesta perspectiva, foi feita uma lista das obrigatoriedades levando em consideração as prioridades dos interessados no sistema, postas para serem trabalhadas. Na implementação das funcionalidades preocupou-se sempre com questões como: sincronia no desenvolvimento e adequação das propostas em relação a mudanças de requisitos, quando necessário, para melhoria na identificação de possíveis impedimentos no desenrolar da construção das funcionalidades.

Para estabelecer uma melhor compreensão o diagrama de caso de uso da Fig.1 apresenta uma visão geral das funcionalidades levantadas a serem distribuídas para os dois tipos de atores envolvidos na utilização do sistema. O caso de uso é uma abordagem da *Unified Modeling Language* (UML) em forma de diagramas que fornece uma visão dos requisitos do sistema na perspectiva do usuário⁽¹⁰⁾. Desta forma cada caso de uso define um conjunto de funcionalidades a serem implementados no sistema.

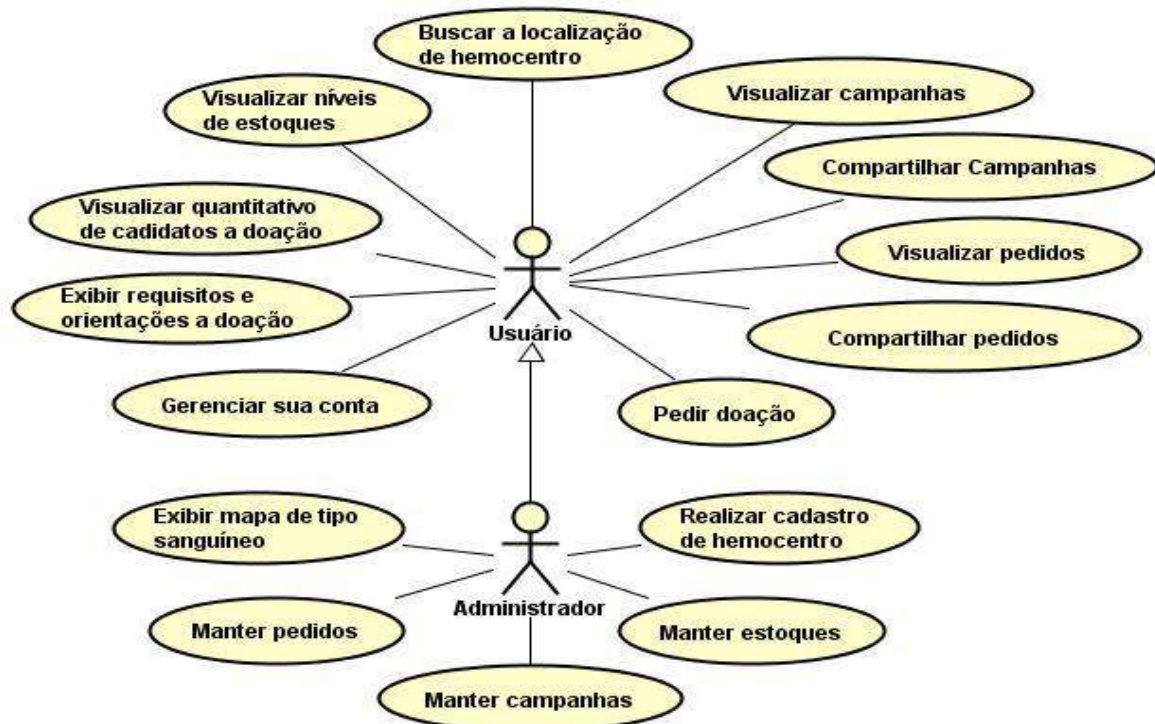


Fig.1– Visão geral das funcionalidades do sistema

Os requisitos levantados descrevem as funcionalidades da aplicação. Cada requisito foi detalhado à medida que novas funcionalidades eram adicionadas possibilitando planejar cada passo a ser seguido para adição de novas funcionalidades no sistema e o versionamento das implementações das funcionalidades do sistema. Os requisitos funcionais do sistema estão listados na Tabela 1em que se tem uma divisão em módulo do usuário e do administrador seguido da ordenação e de uma descrição dos requisitos levantados juntos aos interessados no desenvolvimento do sistema.

Tabela 1– Levantamento de requisitos funcionais para a aplicação Web e Mobile.

MÓDULO USUÁRIO	
Requisitos	Descrição
RF1	Cadastro do usuário no sistema.
RF2	Exibir requisitos e orientações para doação.
RF3	Visualizar quantitativos de candidatos à doação.
RF4	Visualizar níveis de estoques de sangue do hemocentro/hemonúcleo.
RF5	Buscar a localização de hemocentros.
RF6	Visualizar campanhas.
RF7	Compartilhar campanhas.
RF8	Visualizar pedidos de doações.
RF9	Compartilhar pedidos de doações.
RF10	Realizar pedido de doações.
MÓDULO ADMINISTRADOR	
RF11	Gerenciar usuário.
RF12	Manter cadastro de hemocentros.
RF13	Manter informações de estoques de coleta do hemocentro.
RF14	Manter campanhas de coleta de sangue.
RF15	Manter pedidos de doação de sangue.
RF16	Exibir mapa de tipo sanguíneo e fator RH (Grupo Sanguíneo).

Legenda: RF – Requisito Funcional; 1 a 16 – Enumeração.

Foi projetada a implantação do sistema para ser executado em um servidor de aplicação na rede mundial de computadores principalmente para ser utilizado pelo administrador e assim, prover recursos para a aplicação *Mobile*. Desta forma para acessar as principais funcionalidades disponibilizadas do sistema, os usuários necessitam de acesso à *Internet*, fazer uso de um navegador (*browser*) e em casos de funcionalidades restritas de realizar a adequada autenticação na aplicação.

3.1 APLICAÇÃO DE SERVIÇOS WEB

Foi essencial traçar uma independência dos códigos, e assim, organizou-se o sistema em camadas seguindo o *Model View Control (MVC)*⁽¹¹⁾ para através da aplicação *Mobile* ser possível acessar recursos providos pela a aplicação de serviços *Web* por meio da disponibilização de recursos da *Application Programming Interface (API)*. Desta maneira, isolando as regras de negócios das suas principais interfaces gráficas, atentando para aspectos de segurança e proporcionando uma separação entre os componentes das camadas.

Todo o projeto do servidor de serviços *Web* seguiu princípios da orientação a objetos em que foi utilizado principalmente abordagem da linguagem de programação *Java*^{TM(12)} para o desenvolvimento da aplicação e disponibilização de serviços *Web (Webservices)*. Entretanto, em apoio a esta linguagem foram utilizadas outras tecnologias, usufruindo sempre o que de melhor tenham a oferecer, em cada camada, para promover uma boa experiência aos usuários da aplicação.

A Fig.2a apresenta as camadas e as principais tecnologias e recursos utilizados na implementação do sistema seguindo a abordagem de múltiplas camadas para melhor dividir as responsabilidades.

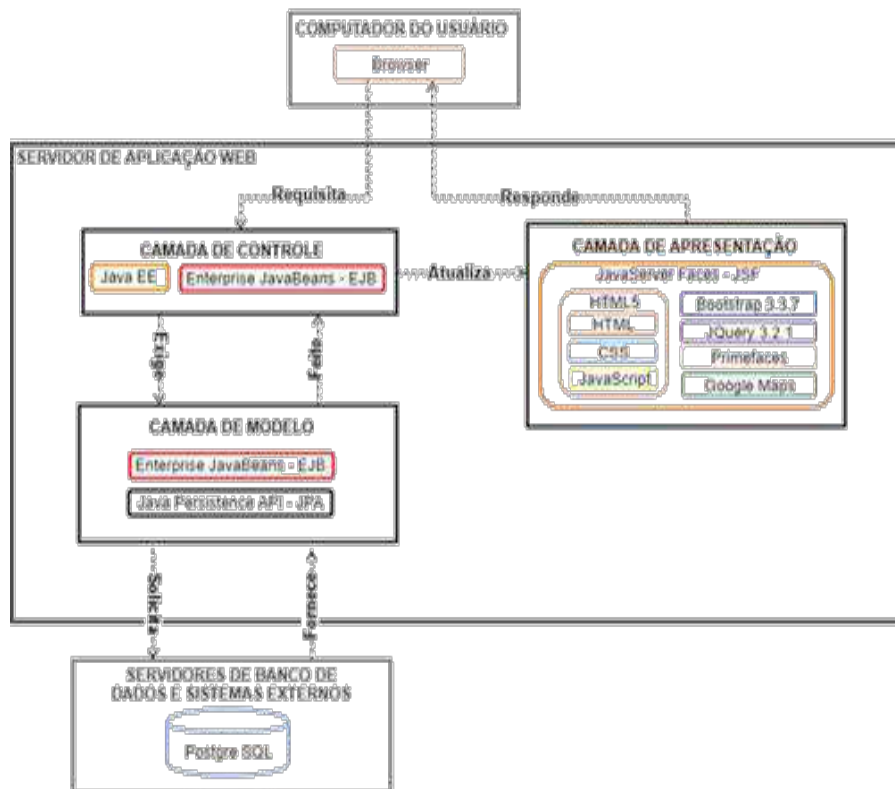


Fig.2– Visão geral das tecnologias usadas nas camadas do sistema de serviços Web

Esta abordagem de múltiplas camadas permite a inserção de mais recursos e/ou criação de interfaces ou até mesmo novas camadas, sem alterar o código do modelo de negócio, permitindo trabalhar em recursos de uma determinada camada sem a problemática direta de fragilizar as demais e com isso, potencializando a manutenibilidade sem perdas na realização das operações do sistema.

3.1.1 Camada de apresentação

A camada de apresentação fornece aos usuários da aplicação a possibilidade de interação com as funcionalidades e recursos disponibilizados pelo MútuoSanguíneo. Os usuários por meio do uso de *Browser* (navegadores *Web*) podem interpretar os recursos estáticos, dinâmicos, entre outros, utilizados para construção das páginas do sistema.

A camada de apresentação recebe atualizações das informações referentes às requisições feitas pelos navegadores à camada de controle, e assim, interagindo dinamicamente com os usuários, mostrando nas páginas do sistema, tais informações, conseqüentemente a serem apreciadas pelos interessados.

Objetivando alcançar tal dinamicidade foram utilizadas versões mais recentes da especificação JavaServer Faces (JSF)¹ integrada a JEE e gerenciado por um servidor de aplicação. Usou-se o PrimeFaces² apropriando-se da sua principal característica de biblioteca de interface gráfica para interagir com o projeto JSF.

Também foi adotado preceitos do HTML5 abrangendo o HTML propriamente dito, o CSS e o JavaScript. O CSS em conjunto com o *framework* Bootstrap³ para proporcionar uma amigável visão das páginas e o JavaScript em conjunto com o *framework* JQuery⁴ para manipulação de dados principalmente vindos do Google Maps⁵.

3.1.2 Camada de controle

A camada de controle proporciona a relação com os artefatos da camada de apresentação e a camada de modelo, estabelecendo a relação entre cada recurso a serem consumidos e/ou usados. Esta camada se responsabiliza por receber as requisições dos navegadores *Web* e exigir da camada de modelo a realização da requisição, como também receber a resposta da camada de modelo e atualizar a camada de apresentação proporcionando aos usuários apreciarem as respostas para a solicitação.

Para realização da intermediação, a camada de controle foi construída basicamente por recursos e abordagem do EJB associada a JEE, possibilitando receber as requisições dos navegadores, acessando os dados oferecidos pela camada de modelo, e assim, realizar as interações necessárias entre visões do sistema para controlar como esses dados são apresentados.

3.1.2 Camada de modelo

A camada de modelo fornece a interação entre todas as regras de negócios do sistema, por meio de investidas que proporcionem constância e permanência das informações fazendo uso dos instrumentos de persistências das informações.

Para manter as informações se faz necessário a construção de componentes distribuídos, proporcionando transações e portabilidade por meio dos componentes do JEE como do EJB. Além disso, para interação com os servidores de banco de dados, usou-se abordagem do provedor do Java Persistence API (JPA)⁶, visando a persistência dos dados e a validação das entidades.

Na perspectiva da permanência dos dados, foi tido como base para construção da persistência definições do PostgreSQL⁷, através das especificações JPA, possibilitando a verificação e validação dos dados a serem constantemente analisados no uso do MútuoSanguíneo.

3.2 APLICAÇÃO MOBILE

O aplicativo *Mobile* também foi projetado seguindo a abordagem de múltiplas camadas para melhor dividir as responsabilidades da aplicação. A Figura 3 apresenta as camadas e as principais tecnologias e recursos utilizados na implementação da parte *Mobile*.

¹<http://www.oracle.com/technetwork/java/javaee/javaserverfaces-139869.html>

²<https://www.primefaces.org/>

³<https://getbootstrap.com/>

⁴<https://jquery.com/>

⁵<https://developers.google.com/maps/?hl=pt-br>

⁶<http://www.oracle.com/technetwork/java/javaee/tech/persistence-jsp-140049.html>

⁷<https://www.postgresql.org/>

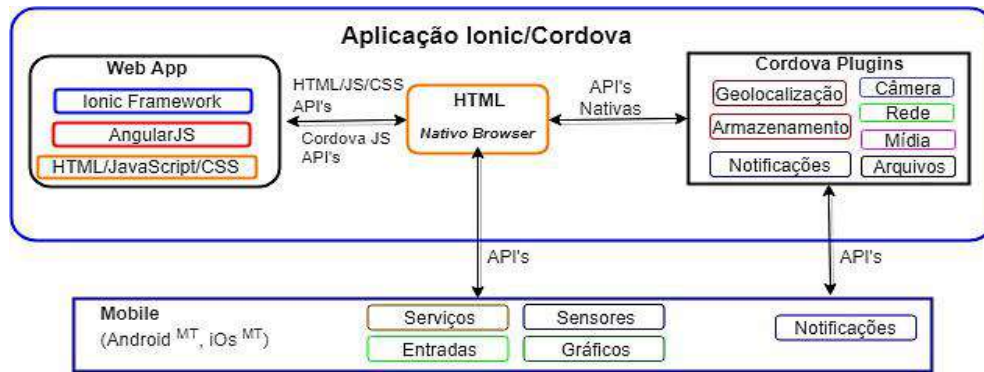


Fig.3 – Visão das tecnologias usadas para construção do aplicativo Mobile

Fazendo uso do IONIC framework⁸, o qual proporciona diversas bibliotecas de Cascading Style Sheets (CSS) e JavaScript para AngularJS⁹, foi possível simplificar o trabalho de desenvolvimento necessitando de conhecimento, apenas de HTML, CSS, JavaScript. Como também, usando o Cordova¹⁰ para encapsular o código feito com IONIC foi possível compilar para formatos a serem instalados nos principais sistemas operacionais do mercado (Android^{MT}, iOS^{MT}).

3.3 IMPLEMENTAÇÃO

Como resultado deste trabalho foi desenvolvido um sistema Web que prover serviços e um aplicativo Mobile colaborativo (MútuoSanguíneo) para contribuir no processo de doação de sangue. Além da disseminação das necessidades de doação sanguínea, o sistema também tem como proposta tornar mais acessíveis informações pertinentes para candidatos à doação de sangue. Auxiliando na aplicação da Política Nacional de Promoção da Doação Voluntária de Sangue disponibilizando um ambiente mútuo aos usuários do sistema possibilitando difundirem as motivações e razões para se tornar doador, contribuírem para propagar as orientações, os critérios, as campanhas e os pedidos para aqueles que necessitam de doação de sangue.

Tomando como ponto de partida o levantamento de requisitos da aplicação, temos as implementações das funcionalidades do MútuoSanguíneo como as principais para o entendimento do sistema Web e do aplicativo Mobile. Exibir requisitos e orientação para doação às orientações aos candidatos à doação de sangue conforme apresenta a Fig.3 possibilita conhecer os principais critérios, orientações e impedimentos para realizar a doação de sangue.

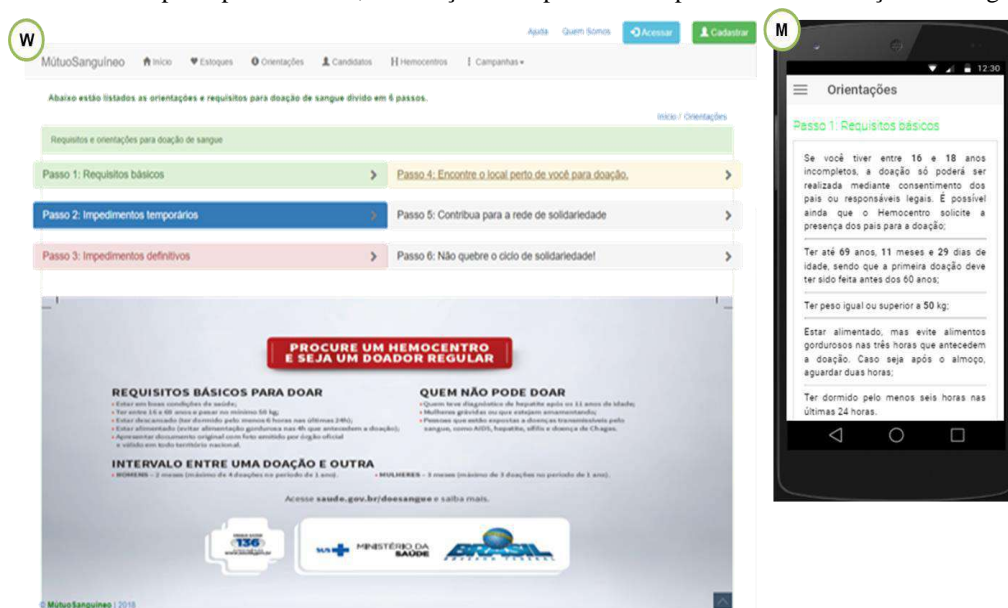


Fig.3– Página Web e Mobile de requisitos e orientações para doação (RF2)

⁸<https://ionicframework.com/>

⁹<https://angularjs.org/>

¹⁰<https://cordova.apache.org/>

Visualizar níveis de estoques do hemocentro/hemonúcleo, ou seja, níveis de estoques de coletas de sangue do hemocentro/hemonúcleo é também um importante requisito para a cativação de novos doadores. Condizente com a realidade de cada hemocentro/hemonúcleo é o ponto principal para que novas campanhas sejam trabalhadas, visando a manutenibilidade dos níveis dos bancos de coletas. Conforme apresenta a Fig.4 com uma exibição por tipo sanguíneo para dado hemocentro/hemonúcleo pesquisado, o propósito primordial desta funcionalidade é com este levantamento ser possível a percepção de quais tipos sanguíneos estão em baixa, precisando de novas doações.

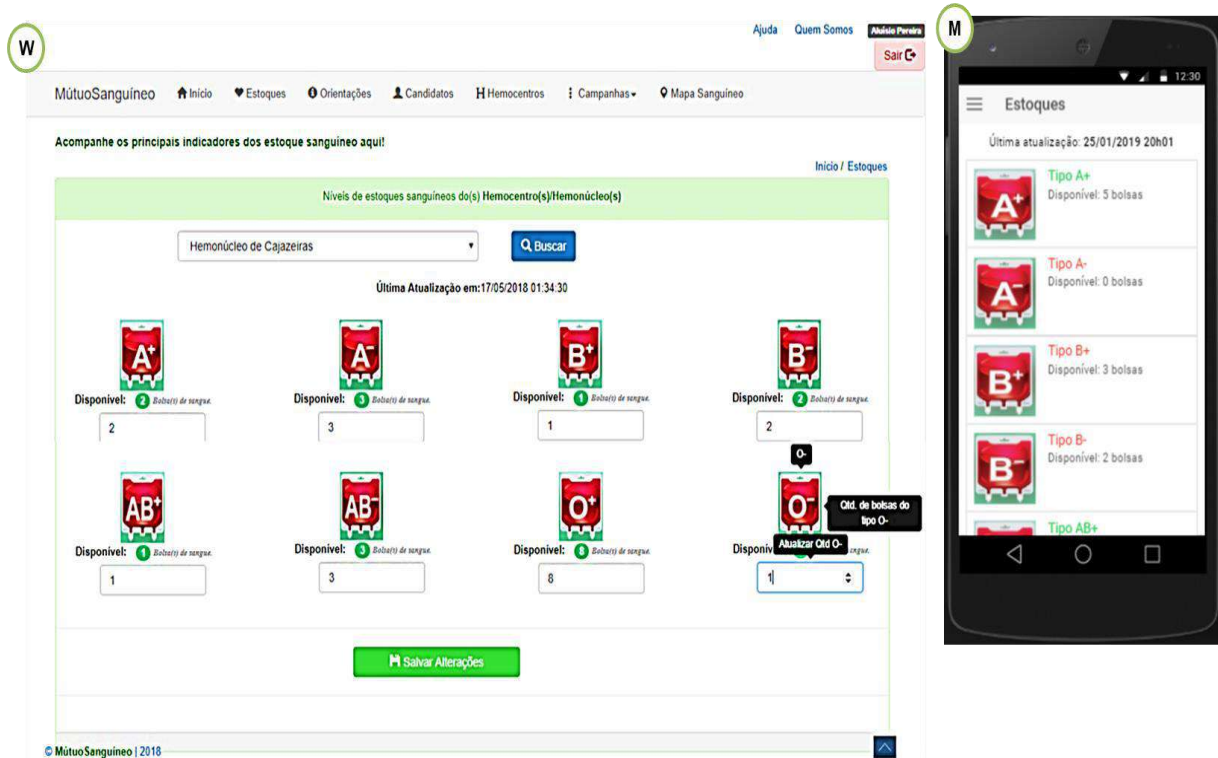


Fig.4– Página Web e Mobile de níveis de estoques do hemocentro/hemonúcleo (RF4 e RF13)

Buscar a localização de hemocentros cadastrados no sistema visa assessorar os candidatos à doação de sangue a identificarem os locais apropriados para o exercício da prática. Para a construção deste requisito se fez necessário seguir as especificações do *Google Places API*¹¹, tendo com isso uma associação dos dados no mapa à real localização da unidade de coleta cadastrada.

Os usuários administradores podem por meio da funcionalidade de gerenciar usuários, manter os usuários do sistema possibilitando aos mesmos ao acessarem a página de candidatos à doação, conforme Fig.5, optar por visualizar informações dos usuários, atualizar informações de cadastro, assim como excluir usuários do sistema.

Caso opte por editar os dados do usuário o administrador será direcionado para um ambiente para realização da edição dos dados do usuário cadastrado. Porém caso opte por excluir o usuário, ao administrador apresentado à devida confirmação de exclusão do usuário e mediante confirmação afirmativa o usuário é excluído da base de dados.

¹¹<https://developers.google.com/places/?hl=pt-br>

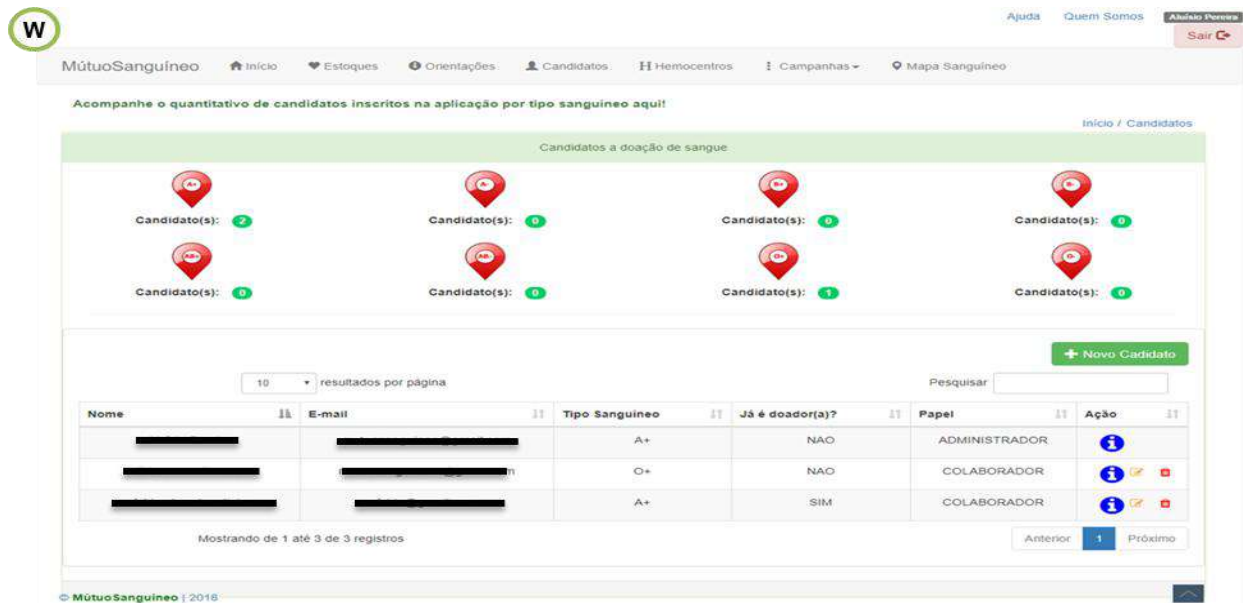


Fig.5– Tela Web de gerenciamento de usuários

Já se o administrador optar por visualizar informações do usuário o administrador será redirecionado para uma página em que poderá contemplar mais informações do usuário podendo assim, exibir as informações cadastradas para cada usuário requisitado, como também ver informações da localização fornecida pelo usuário em mapa. O sistema busca na base de dados às informações referentes ao usuário e apresenta conforme apresenta a Fig.6.

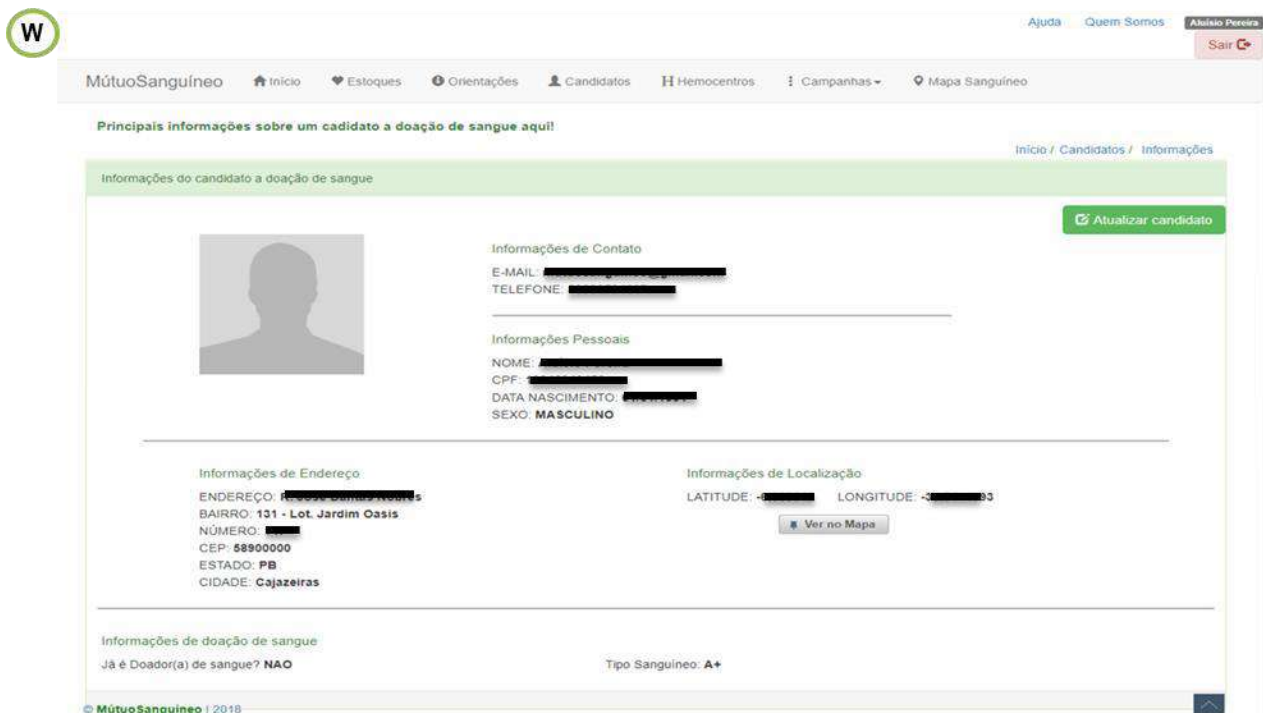


Fig.6– Tela Web para visualização do usuário

Para melhor entender, a Fig.7, apresenta a página com uma lista dos hemocentros/hemonúcleos cadastrados no sistema. As informações apresentadas ao usuário são referentes a cada instituição de coleta, exibindo o nome, o endereço, o estado e a cidade de localização, o tipo de atividade que a instituição tem capacidade de realizar e o telefone da instituição.

Como também ao clicar no botão com texto “Localização no Mapa” referente a um hemocentro/hemonúcleo, o sistema apresenta uma visualização da localização da instituição de coleta no mapa conforme a Fig.8. Para isso, tanto o

o sistema Web como o aplicativo realiza uma busca na base de dados e retorna as coordenadas latitudes e longitude devidamente cadastradas para a construção da localização e assim, centralizando e marcando no mapa a posição referente à unidade de coleta.

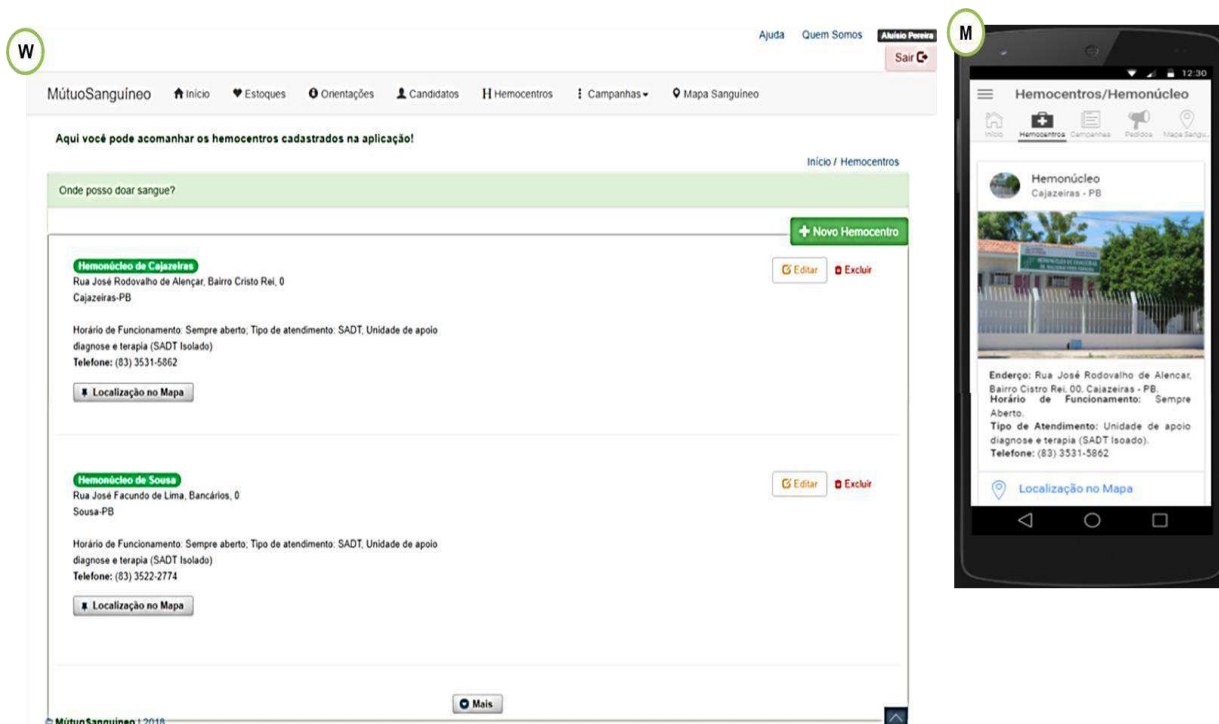


Fig.7– PáginaWeb e Mobile dos hemocentros/hemonúcleos cadastrados (RF5 e RF12)

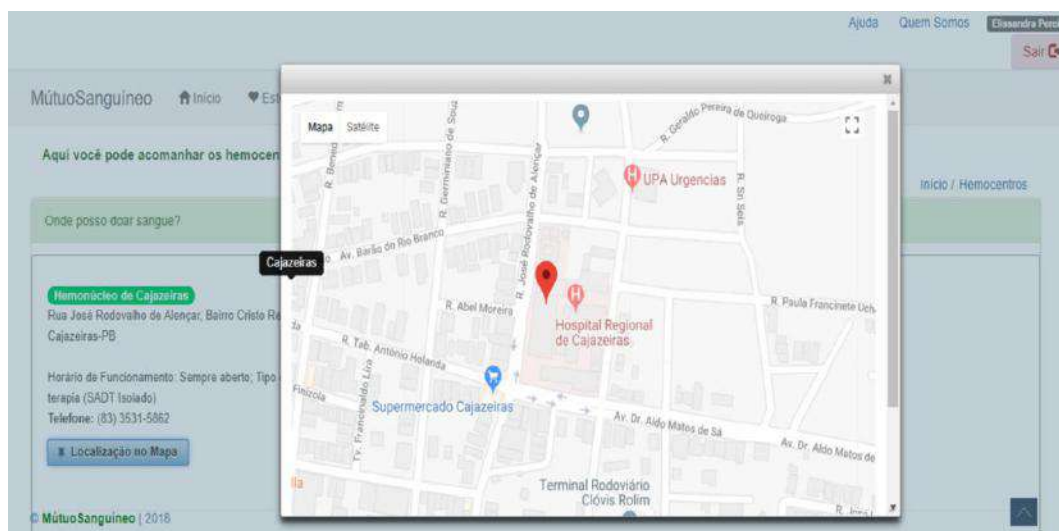


Fig.8 – Página Localização no Mapa do hemocentro/hemonúcleo.

A exibição do mapa de tipo sanguíneo e fator RH (Grupo Sanguíneo), também é uma funcionalidade essencial do sistema, uma vez que a mesma proporcionar ao administrador dos hemocentros/hemonúcleo vislumbraas informações disponibilizadas pelos usuários ao se cadastrarem na aplicação, possibilitando com isso apoiar a tomada de decisões, buscando atrair novos doadores, assim como para fins de manutenção dos níveis de estoques, permitindo por meio das informações desta funcionalidade trabalhar campanhas e ações de coletas ambulatoriais voltadas para dadas regiões /bairros de uma cidade, dependendo do quantitativo de candidatos à doação nestas proximidades e as necessidades do hemocentro em questão. Por meio da página de mapa sanguíneo, conforme apresenta a Fig.9, o usuário administrador se depara com um

ambiente para a exibição no mapa, a partir das informações fornecidas (tipos sanguíneos, estado e cidade) para realização da busca, a marcação das coordenadas de candidatos à doação de sangue cadastrado na aplicação que optaram em fornecer as informações de localização, referentes resultados relativos às informações.

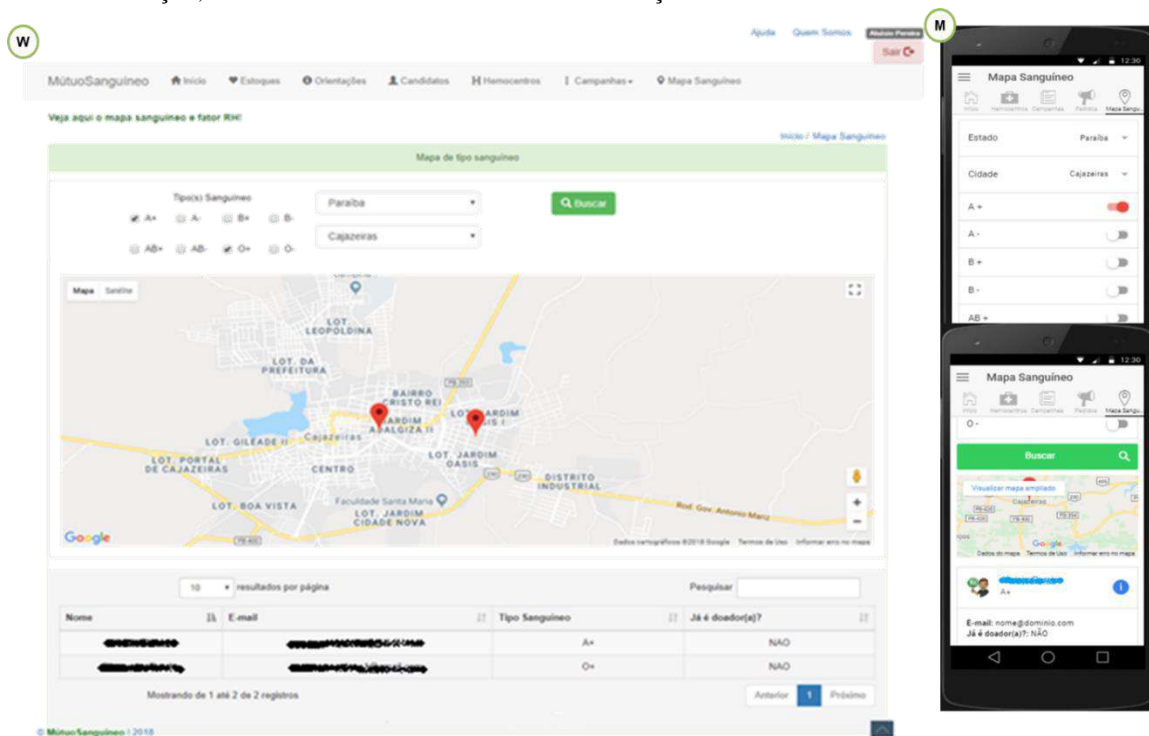


Fig.9– TelaWeb e Mobile visualização do mapa por tipo sanguíneo (RF16)

A Fig.10 apresenta um agrupamento com das demais implementações.

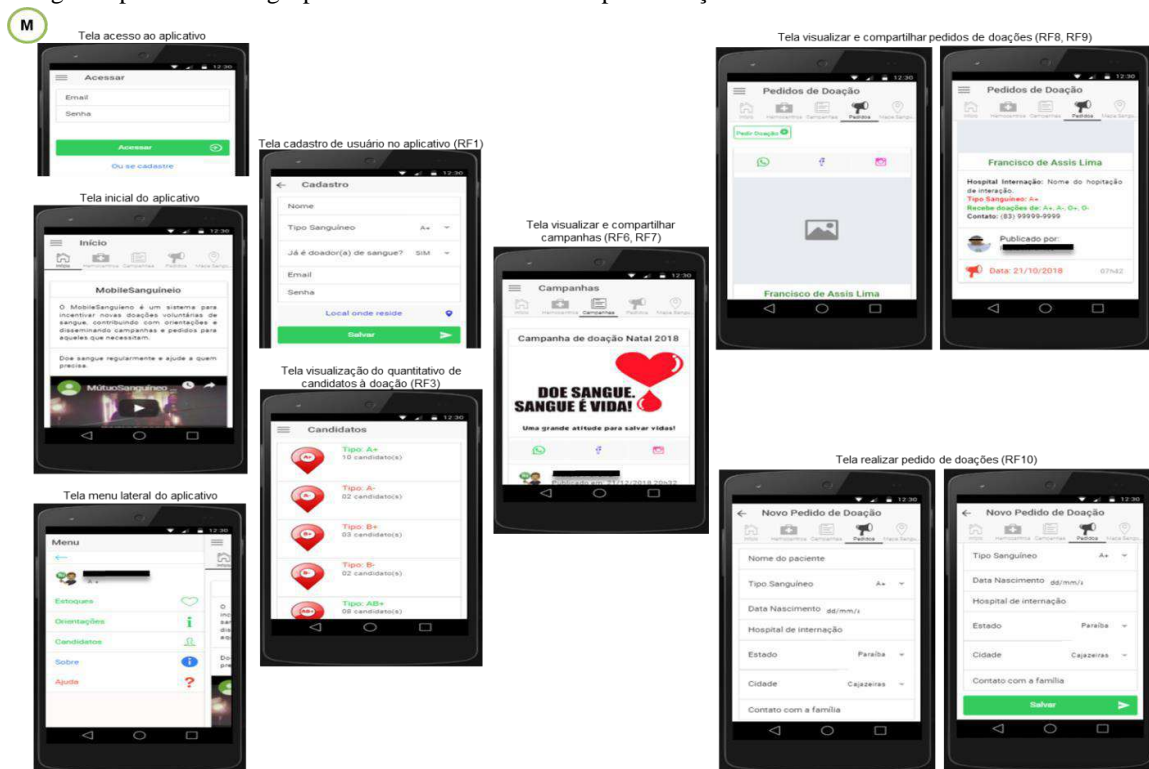


Fig.10 – Agrupamento de figuras das telas do aplicativo Mobile (RF1, RF3, RF6, RF7, RF8, RF9 e RF10)

No decorrer do desenvolvimento do sistema foi realizado o lançamento e validação de oito versões, para análise junto aos interessados no Hemonúcleo de Cajazeiras – PB, o qual obteve a confirmação e o posicionamento do(a) representante institucional em cada caso de “Excelente” para as implementações das funcionalidades conforme exemplifica e apresenta Fig.11. Sendo assim, possível contemplar a Versão 0.8 alcançando os objetivos inicialmente descritos para o desenvolvimento do sistema colaborativo deste estudo.

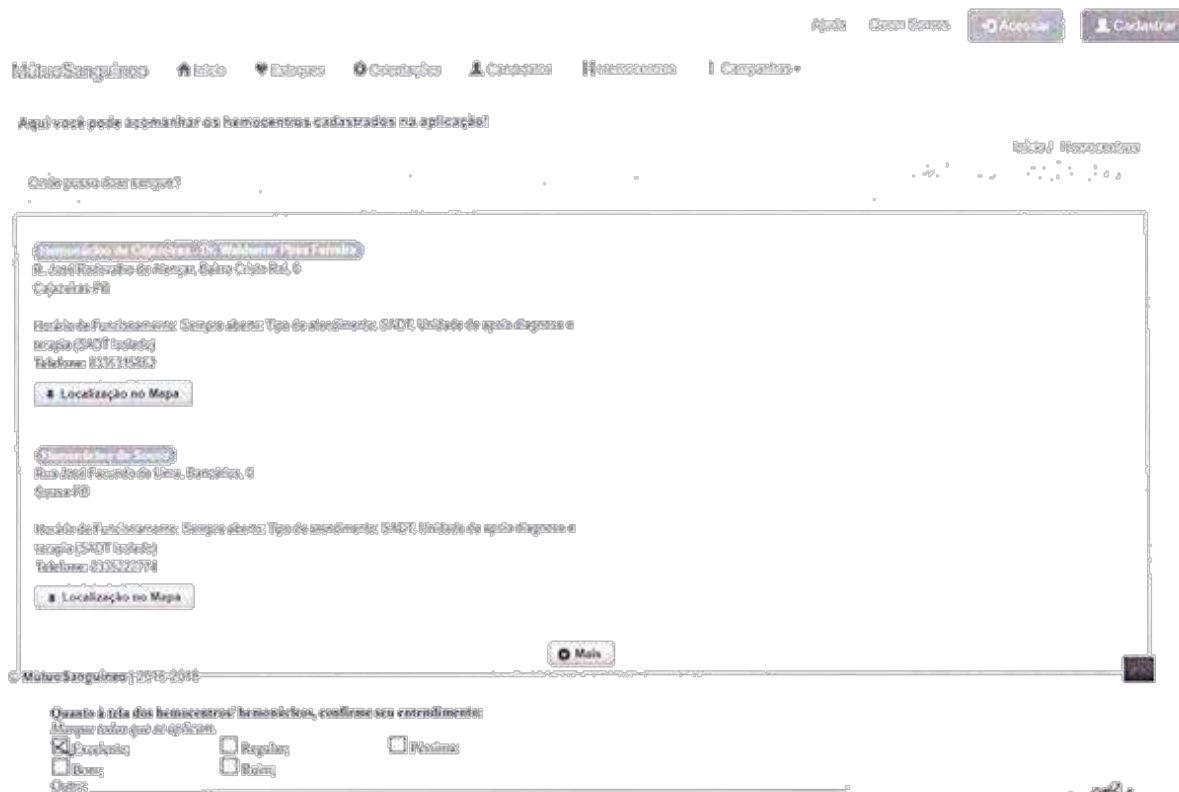


Fig.11 – Questionário de aceitação e posicionamento quanto à implementação para a tela das informações e localização dos hemocentro/hemonúcleo

Através da definição da região de Cajazeiras, Paraíba, Brasil como principal circunscrição para a realização deste estudo, foi possível também levantar ferramentas com propostas parecidas ao MútuoSanguíneo, encontrando os sistemas (S) que mais se assemelham, sendo eles:

- S1 HemoLiga¹²;
- S2 Doe Sangue PB¹³;
- S3 Blog Hemonúcleo Cajazeiras¹⁴.

Adotando uma perspectiva qualitativa, os sistemas S1, S2 e S3 com propostas semelhantes serviram como base para ser realizado um estudo comparativo entre as funcionalidades contempladas por tais sistemas e destacar as peculiares ao sistema colaborativo desenvolvido neste trabalho conforme apresenta a Tabela 2.

Tabela 2– Comparação entre sistemas relacionados e o sistema deste estudo

FUNCIONALIDADES	S1	S2	S3	MútuoSanguíneo
Cadastro de candidatos	✓	✗	✗	✓
Cadastro de voluntários para participar de campanhas	✗	✓	✗	✗

¹²<http://hemoliga.com.br>
¹³<http://doesanguepb.com.br>
¹⁴<http://hemonucleocajazeiras.blogspot.com.br>

Exibir requisitos e orientações para doação.	✓	✓	✓	✓
Exibir quantidade de cadastrados por tipo sanguíneo.	✗	✗	✗	✓
Gerar identificação de doador	✓	✗	✗	✗
Exibir informações de estoques do hemocentro.	✓	✗	✗	✓
Exibir informações de estoque por tipo sanguíneo.	✓	✗	✗	✓
Exibir locais de doação.	✓	✓	✓	✓
Exibir localização de hemocentro no mapa	✓	✗	✗	✓
Realizar pedido de doação de sangue.	✗	✓	✗	✓
Compartilhar pedido de doação de sangue.	✗	✗	✗	✓
Divulgação de campanhas de coleta de sangue.	✓	✓	✓	✓
Compartilhar campanhas de coleta de sangue.	✗	✗	✗	✓
Permitir gerar dúvidas, sugestões, reclamações.	✗	✓	✗	✗
Exibir mapa de tipos sanguíneo por cidade.	✗	✗	✗	✓

Legenda: S1 – HemoLiga; S2 – Doe Sangue PB; S3 – Blog Hemonúcleo Cajazeiras; ✓ – possui a funcionalidade; ✗ – não possui a funcionalidade.

Observando o comparativo da Tabela 2 é possível perceber que o MútuoSanguíneo (sistema *Web* e aplicativo desenvolvidos) proporciona uma compatibilização entre funcionalidades mescladas pelos demais sistemas, assim como, apresenta funcionalidades peculiares como é o caso da exibição do mapa sanguíneo de candidatos a doação de sangue.

IV. CONCLUSÃO

O MútuoSanguíneo desenvolvido é uma iniciativa que visa facilitar a interação entre instituições coletoras de sangue, doadores e pacientes. Por meio das funcionalidades existentes tanto no sistema *Web* e no aplicativo, os envolvidos contribuem espontaneamente para disseminar as ações de apoio e incentivo à prática da doação de sangue.

Com a realização deste trabalho foi possível entender que as práticas da Política Nacional de Promoção da Doação Voluntária de Sangue no Brasil podem ser apoiadas por abordagem como a resultante do presente estudo. Foi possível também adquirir, conhecer e entender que um processo de desenvolvimento de sistemas *Web* e *Mobile* possibilita uma interação constante com os interessados na abordagem proposta produziu como resultado uma melhor produtividade e aceitação, permitindo uma boa experiência na aplicação de metodologias ágeis para melhor organizar etapa do trabalho.

Na versão atual do sistema desenvolvido neste estudo, o mesmo já proporciona um ambiente que possibilita aos usuários realizar pedidos de doações de sangue para paciente específico, divulgar campanhas de abrangência geral, consultar informações dos locais para doação, se manter atualizado sobre os níveis de estoque de sangue dos hemocentros e orientar-se sobre os procedimentos necessários para se tornar doador de sangue.

REFERÊNCIAS

- [1] BRASIL. Ministério da Saúde. **Apenas 1,8% dos brasileiros são doadores de sangue**. Governo do Brasil. 2017. Disponível em: <<http://www.brasil.gov.br/saude/2017/06/apenas-1-8-dos-brasileiros-sao-doadores-de-sangue>>. Acesso em: 18 fev. 2018.
- [2] BRASIL. Ministério da Saúde. **Manual de orientações para promoção da doação voluntária de sangue**. Secretaria de Atenção à Saúde. Departamento de Atenção Especializada e Temática. – 1. ed., 1. Reimpr. Brasília, 2015.
- [3] GUIMARÃES, J. **Ministério da Saúde gastou R\$ 532 milhões em publicidade nos últimos três anos**. Portal R7. 2016. Disponível em: <<https://noticias.r7.com/saude/ministerio-da-saude-gastou-r-532-milhoes-em-publicidade-nos-ultimos-tres-anos-19052016>>. Acesso em: 22 jan. 2018.
- [4] CAVALCANTI, L. **Ministério da Saúde lança campanha para incentivar doação de sangue**. Correio Brasiliense 2017. Disponível em: <http://www.correiobraziliense.com.br/app/noticia/brasil/2017/06/14/internas_polbraeco,602576/ministerio-da-saude-lanca-campanha-para-incentivar-doacao-de-sangue.shtml>. Acesso em: 21 fev. 2018.
- [5] MASSUCHETTO, Vinícius André. **Sistemas colaborativos de apoio à decisão: uma proposta de combinação de metodologias para a geração de alternativas estratégicas**. São Paulo: IPEN, 2015. Dissertação (Mestrado) – Instituto de Pesquisas Energéticas e Nucleares, Autarquia associada à Universidade de São Paulo, 2015.
- [6] BORGES, Marcos Roberto da Silva. **Uma análise do desenvolvimento de Sistemas Colaborativos apoiado em Práticas Ágeis**. Rio de Janeiro: UFRJ, 2015. UFRJ - Universidade Federal do Rio de Janeiro, 2015.

- [7] RIOS, J. A; REIS, L. R. dos; SOUZA, C. R. B de. **Comunidades de práticas baseadas na web**: um estudo de caso no programa profuncionário. Louro Feitas: IFBA, 2017. OBRA DIGITAL, Núm. 14, Febrero - agosto 2018, pp. 102-123, e-ISSN 2014-5039.
- [8] PRESSMAN, R. S; MAXIM, B. R. **Engenharia de software**: uma abordagem profissional. 8. ed. Porto Alegre: AMGH, 2016.
- [9] SCHWABER, K; SUTHERLAND, J. **Um guia definitivo para o Scrum**: As regras do jogo. Processo de Desenvolvimento de Software, 2013.
- [10] GUEDES, G. T. A. UML 2: uma abordagem prática. 2. ed. São Paulo: Novatec Editora, 2011.
- [11] BAPTISTELLA, A. J. **Abordando a arquitetura MVC e Design Patterns**: Observer, Composite, Strategy. 2015. Disponível em: <<http://www.linhadecodigo.com.br/artigo/2367/abordando-a-arquitetura-mvc-e-design-patterns-observer-composite-strategy.aspx>>. Acesso em: 16 jan. 2018.
- [12] ORACLE. Java Platform, Enterprise Edition. **Release 7**. September 2014. Disponível em: <<https://docs.oracle.com/javase/7/tutorial/title.htm>> Acesso em: 17 fev. 2018.

Oxidation time of Ascorbic Acid in two different types of Solutions

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Abstract— The article evaluated the survival function and time of failure (ascorbic acid oxidation) in natural fruit juices, comparing to oxidation of this vitamin in simple aqueous medium. The analysis showed that the oxidation in natural fruit juices (orange, barbados cherry and cashews) have failed quickly compared to simple aqueous medium.

Keywords— Survival Function. Risk ratio. Vitamin C.

I. INTRODUCTION

Antioxidants are chemical compounds that can prevent or reduce the oxidative damage of lipids, proteins and nucleic acids caused by reactive oxygen species, which include free radicals, that is, antioxidants have the ability to react with free radicals and thus restrict the harmful effects on the body. Antioxidant supplementation can be used in situations where normal body defense mechanisms are not sufficient to attenuate the harmful action of free radicals from metabolic activities (Picchio et al., 2013).

Natural substances exhibit antioxidant activities that help decrease the incidence of cardiovascular disease, inflammation, brain dysfunction, and delay early aging (ROCHA et al., 2013).

Fruits and vegetables contain many compounds with potential antioxidant activity, such as phytochemical antioxidants, including simple phenolic compounds, glycosides and flavonoids such as vitamins C and E. Vitamin C also helps the body maintain levels of vitamin E, liposoluble antioxidant, and also acts as an anti-stress agent, favoring the reduction of glucocorticoid rates (FERNANDES et al., 2013).

Most of the antioxidants present in citrus are vitamin C and polyphenols, especially flavonoids. Vitamin C provides protection against uncontrolled oxidation in the aqueous medium of the cell, due to its high reducing power. Polyphenols are substances with great power to neutralize the molecules of free radicals (KLIMCKAC; PATIL, 2007).

Vitamin C is the common name given to 2,3-enediol-L-gulonic acid which is a powerful antioxidant because it prevents oxidation, that is, the loss of electrons. The body has different antioxidant defense systems, however, when imbalance occurs in the antioxidant defense, there is an increase in the number of free radicals, a process known as oxidative stress. Ascorbic acid (vitamin C) molecules undergo oxidation before other molecules oxidize, preventing and protecting these other oxidation molecules (BIANCHI; ANTUNES, 1999).

It is known that during food storage and processing, most vitamins can be spoiled due to chemical reactions, especially by oxidation. This is a serious problem, especially in relation to the conditioning of natural foods, since the simple contact with the oxygen of the air during the storage time favors the oxidation reactions of the vitamins inherent in the composition of these foods (BRITO et al.) Foods like cashew, acerola and orange have high amounts of ascorbic acid, and are generally ingested by man in the form of juices. As soon as the juice of these fruits is extracted, the process of oxidation of vitamin C by the oxygen of the air begins, which means that in the course of time the amount of ascorbic acid present in the juice decreases. Oxidation may be represented by the conversion of ascorbic acid to dehydroascorbic acid as shown in

Figure 1.

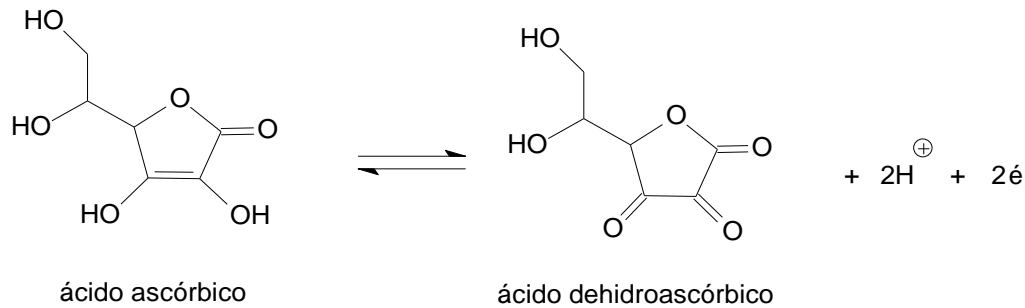


Fig.1: Oxidation of ascorbic acid to dehydroascorbic acid.

Source: Organized by the authors.

In this sense, the study of the failure time, or the occurrence of the oxidative process of ascorbic acid, in different solutions and in ambient conditions, allows to evaluate packaging and preparation techniques, in order to optimize its use and consumption. Therefore, the present study aims to evaluate the failure time and risk function of ascorbic acid oxidation in natural fruit juices, comparing to the oxidation of this vitamin in a simple aqueous medium

II. MATERIALS AND METHODS

2.1. Sample Preparation Planning and Procedures

To carry out the analyzes, oxidation titrations were made using iodine solution (I₂) 0.01 molL⁻¹ as titrant and starch (1%) as indicator of the turning point. The iodine (I₂) acts as an oxidizing agent, causing oxidation of the ascorbic acid contained in the solution to dehydroascorbic acid. Initially the solution is colorless, but when there is excess iodine, ie all ascorbic acid has been oxidized, this solution turns blue, indicating the end of the titration.

For determination of the ascorbic acid content in orange juice, 25.0 ml of orange juice was pipetted and transferred to a 100.0 ml volumetric flask and the volume was quenched with distilled water. Then 25.0 mL of this solution was pipetted into a 125.0 mL Erlenmeyer flask and 5.0 mL of 1% starch indicator solution (m / m) was added. The solution was titrated with 0.01 molL⁻¹ iodine until a permanent blue color appeared. The concentration of ascorbic acid present in the juice over 2.5 h was calculated and then compared with the other results obtained.

Regarding the determination of the oxidation rate of ascorbic acid present in aqueous medium, the same initial amount of ascorbic acid PA present in orange juice solubilized in distilled water was weighed and transferred to a volumetric flask of 1000.0 ml and the volume completed with distilled and deionized water. 25.0 mL of

this solution was then pipetted to a 125.0 mL Erlenmeyer flask, thereby initiating the titration. The concentrations of ascorbic acid present in the aqueous medium over 2.5 h were determined at each 30 minute interval and under magnetic stirring at 7,000 rpm. Then, they were compared with the results obtained in the oxidation of ascorbic acid present in natural fruit juice.

In the analysis of ascorbic acid present in acerola juice, 252.0 g of fruit were used, which produced 125.0 mL of juice after extraction. The juice diluted with 200.0 mL of water, raising to a total volume of 325.0 mL of solution. From this solution were pipetted 25.0 mL and transferred to a volumetric flask of 100.0 mL, completing with distilled water. Then 25.0 mL were pipetted from the volumetric flask to a 125.0 mL Erlenmeyer flask and titrated.

Regarding the determination of the oxidation rate of ascorbic acid present in aqueous medium, the same initial amount of ascorbic acid present in acerola juice was weighed, dissolved in water and transferred to a 1000.0 mL volumetric flask and filled with deionized water. Then 25.0 mL was pipetted into a 125.0 mL Erlenmeyer flask and titrated with 0.01 mol L⁻¹. The concentrations of ascorbic acid present in the aqueous medium in the course of 2.5 h were determined by the same procedure, and then compared with the results obtained in the oxidation of the natural juice.

For the analysis of cashew juice, 440.0 g of the fruit were used, which provided a volume of pure juice, after filtration maceration, of 437.6 mL. To this juice was added 150.0 mL of water, thus raising to a final volume of 587.6 mL of solution. From this solution were pipetted 25.0 mL and transferred to a volumetric flask of 100.0 mL, completing with distilled water. Then 25.0 mL were pipetted from the volumetric flask to a 125.0 mL Erlenmeyer flask and titrated.

Ascorbic acid content of the cashew juice and in aqueous medium were weighed, the same initial amount of ascorbic acid present in the cashew juice was weighed,

dissolved in deionized water and transferred to a 1000.0 mL volumetric flask and volume with distilled water. Subsequently, 25.0 mL were pipetted and transferred to a 125.0 mL Erlenmeyer flask and titrated with 0.01 mol L⁻¹ I₂ solution. The concentrations of ascorbic acid present in aqueous medium in the course of 2.5 h were determined and calculated by the same procedure, and then compared with the results obtained in the natural juice analysis.

The determination of ascorbic acid concentration as a function of the time of exposure to air was carried out at intervals of 30 minutes in triplicates for a period of 2.5 hours, that is, 150 minutes exposed to oxygen from the

air, under agitation at 7,000 rpm. To calculate the mass of ascorbic acid present in each solution, the following procedure was used:

$$\text{Mass of Vitamin C} = M * V * MM, \text{Equation 1}$$

where, M is the molarity of iodine (0.01 molL⁻¹); V is the volume spent in liters of iodine in titration and MM is the molar mass of ascorbic acid (176 mols / g).

In Table 1 the spent volumes of iodine in each titration are described. It should be noted that the volumes of 0.01 molL⁻¹ spent I₂ solution are obtained by the average of three titrations (triplicate) performed.

Table 1: Volumes used of I₂ (0,01 molL⁻¹) in the titrations of preparation of the samples with ascorbic acid, in simple aqueous solutions (SAS) and in natural fruit juices (SNF).

Time (min)	Volume spent (in ml) on the titrations of the simple aqueous solutions			Volume spent (in mL) spent on titrations of natural fruit juices		
	Orange	Acerola	Cashew	Orange	Acerola	Cashew
0	2,65	39,50	7,25	2,65	39,50	7,25
30	2,38	34,80	5,60	2,50	35,55	6,50
60	1,98	31,08	5,24	2,20	31,70	5,85
90	1,78	26,80	4,50	2,00	28,50	5,30
120	1,56	24,38	3,91	1,80	27,00	4,90
150	1,45	23,21	3,26	1,65	26,50	4,35

Source: Prepared by the authors.

2.2. Statistical treatment of collected data

After the data collection, a statistical study was performed with the measurements of ascorbic acid concentration (g / L) in each of the experimental samples. The aim is to demonstrate the failure performance (decrease of the ascorbic acid concentration function) over the time measured in minutes. The log-normal distribution of sample reliability was obtained from the probability density function (pdf), given by:

$$F(t) = \frac{1}{\sigma \sqrt{2\pi}} \exp\left(-\frac{(\ln(x)-\mu)^2}{2\sigma^2}\right), \text{Equation 2}$$

where, μ are the parameters obtained in each sample and, σ is the scale of the parameters evaluated. The estimates of the likelihood function of the parameters are estimated by the maximum likelihood procedure (GIESBRECHT; KEMPTHORNE, 1966).

As for the survival function S (t), which represents in the experiment the probability of an "ascorbic acid" unit of concentration "surviving", above the time interval in t (minutes), is obtained naturally by:

$$S(t) = 1 - F(t), \text{Equation 3}$$

and the confidence limits for a given estimate of the function S (t), is obtained by:

$$S_L(\hat{Z}) = S(\hat{Z}_2), \text{to the lower limits; Equation 4}$$

$$S_U(\hat{Z}) = S(\hat{Z}_1), \text{to the upper limits Equation 5}$$

Where,,

$$Z_1 = \hat{z} - z_\alpha \sqrt{\text{Var}(\hat{z})}; \text{Equation 6}$$

$$Z_2 = \hat{z} + z_\alpha \sqrt{\text{Var}(\hat{z})}, \text{Equation 7}$$

in which, $z_\alpha = (1 + \alpha) / 2$ for the critical value of confidence, given in a standardized normal distribution (RIGDON; BASU, 2000).

Regarding the variance of the survival probabilities (survival probabilities) of the samples, it is given by:

$$\hat{z} = \frac{x - \hat{\mu}}{\hat{\sigma}}, \text{Equation 8}$$

or yet,

$$\hat{z} = \frac{\ln x - \hat{\mu}}{\hat{\sigma}}, \text{Equation 9}$$

And, therefore, for the log-normal distribution, one has:

$$\text{Var}(\hat{z}) = \frac{\text{Var}(\hat{\mu}) + \hat{z}^2 \text{Var}(\hat{\sigma}) + 2\hat{z} \text{Cov}(\hat{\mu}, \hat{\sigma})}{\hat{\sigma}^2} \text{Equation 10}$$

In sequence, the instantaneous failure rate (or hazard rate) was obtained for each time t (in minutes), as shown in the hazard function. It is possible to consider in this specific study, in which phase of experimental life, the probability of occurrence of failure is greater or lesser for each sample group, and also the expectation of its duration (or instantaneous failure rate at a given moment, t)

The risk function is given by:

$$h(t) = \frac{f(t)}{1-F(t)}, \quad \text{Equation 11}$$

where f (t) and F (T) are cdf (cumulative distribution function) and pdf (probability density function), respectively, of the chosen distribution (MEEKER and ESCOBAR, 1998). The Reliability / Survival Analysis package and the Parametric Distribution Analysis-Right

Censoring function of the MINITAB software (version 17) were used for the statistical study.

III. RESULTS AND DISCUSSION

After the determination of the ascorbic acid content in fruit juices, a comparison was made of the oxidation rate of ascorbic acid by air oxygen in fruit juices and also simultaneously a simple aqueous solution containing initially at the initial time, the same amount of ascorbic acid in fruit juices.

From the data presented in Table 2, it can be seen that the oxidation rate of ascorbic acid was higher when compared to the same concentration of ascorbic acid in fruit juice. It is noted that, for example, for orange juice, a concentration of 0.746 g / L of ascorbic acid was exposed prior to oxidation

Tabela 2: Concentrations of ascorbic acid present in simple aqueous solutions (SAS) and natural fruit juices (SNF), at different times evaluated in the study.

Time (min)	Concentration of ascorbic acid (g / L) in single aqueous solution			Concentration of ascorbic acid (g / L) in natural fruit juices		
	Orange	Acerola	Cashew	Orange	Acerola	Cashew
0	0,746	28,920	2,739	0,746	28,920	2,739
30	0,670	25,479	2,117	0,704	26,028	2,458
60	0,557	22,756	1,981	0,619	23,209	2,212
90	0,501	19,622	1,702	0,563	20,866	2,004
120	0,439	17,850	1,478	0,506	19,768	1,853
150	0,408	16,994	1,233	0,465	19,402	1,645

Source: Prepared by the authors.

When subjected to oxidation, the concentration of ascorbic acid found after 30 minutes of stirring was 0.704 g / L, whereas in the simple aqueous solution of ascorbic acid, from the initial concentration of the same 0.746 g / L, a decrease was observed to 0.670 g / L after 30 minutes. This higher oxidation in the simple aqueous solution of ascorbic acid, compared to the oxidation of the ascorbic acid present in the fruit, was observed at all determined times, according to Table 2.

As for the statistical study of the failure time, for samples of Orange in simple aqueous solution (SAS) and in natural fruit juices (SNF), it was noticed that those in aqueous solution failed before and unlike the samples in natural fruit juices (Figure 1). The hazard function indicates that the probability of occurrence of failure (oxidation of ascorbic acid) in the samples in natural juices occurs late, already in the final phase of experimental evaluation.

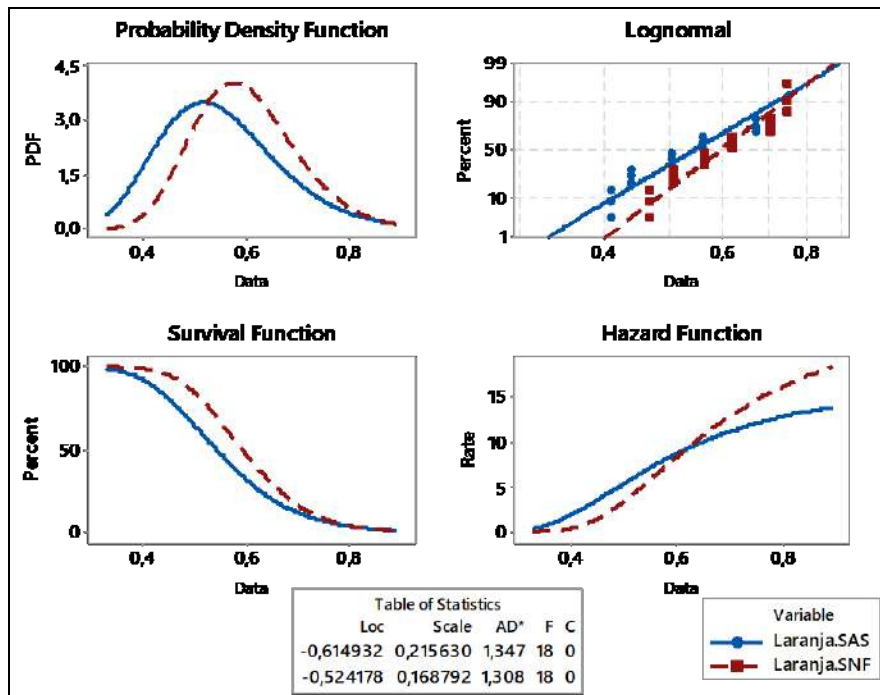


Fig.1: Distribution of the estimates by the maximum likelihood criterion of the complete ascorbic acid (g / L) oxidation data for triplicate samples of orange in single aqueous solution (SAS) and in natural fruit juices (SNF).

Source: Prepared by the authors.

The same considerations can be attributed to the other experimental samples, containing acerola and cashew in simple aqueous solution and in natural fruit juices. In the acerola samples, the survival distribution and the risk rate function are quite similar with the samples containing orange (Figure 2).

In general, the characteristic of the solution is determinant for the distribution of the ascorbic acid concentrations, throughout the time of evaluation of the experiment. The probability of oxidation of ascorbic acid, which is already close to the final phase of the experiment, is more easily perceived from the risk ratio function for the two samples (orange and acerola).

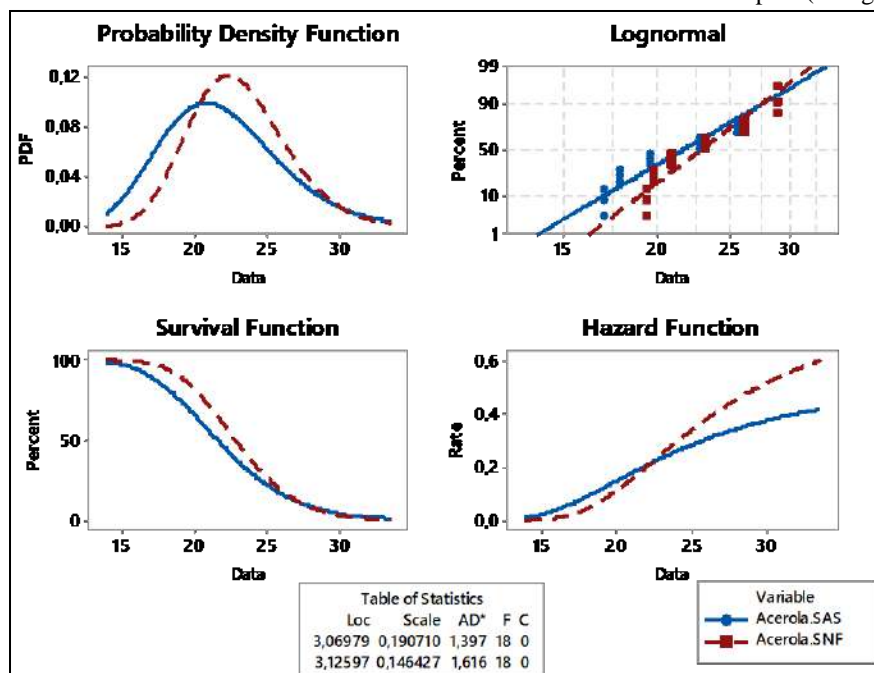


Fig.2: Distribution of the estimates by the maximum likelihood criterion of the complete ascorbic acid (g / L) oxidation data for the triplicate samples of acerola in single aqueous solution (SAS) and in natural fruit juices (SNF).

Source: Prepared by the authors.

Likewise, for Cashew samples in simple aqueous solution and in natural fruit juices, it was observed that those in aqueous solution failed before and unlike samples in natural fruit juices (Figure 3). The hazard function (Hazard Function) has demonstrated that the probability of occurrence of failure in the samples in natural juices is also later in the final phase of experimental evaluation, contrary to what happens in the initial phase of the experiment.

It should be noted that the greatest difference between the distribution of data evaluated in the samples, considering the probability of survival, more extensive in

the treatments with natural fruit juices in relation to the aqueous medium, and in relation to the risk rate function.

For this set of samples (using cashew), the probability of occurrence of failure (oxidation of ascorbic acid) in simple aqueous solution is much less pronounced and, at least visually, a more discrete distribution. Compared to the other samples (orange and acerola), the distance between the hazard rate function in the final phase of the experiment is much wider for the two solution models (aqueous solution versus solution with fruit juice).

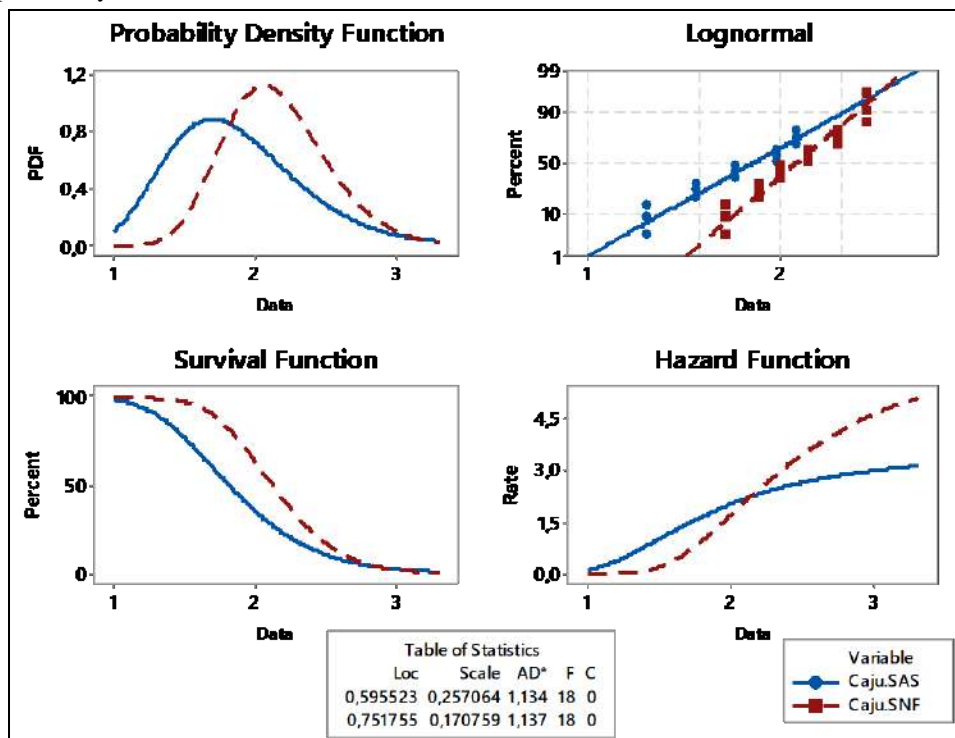


Fig.3: Distribution of the estimates by the maximum likelihood criterion of the complete ascorbic acid (g / L) oxidation data for triplicate samples of cashew nuts (SAS) and natural fruit juices (SNF).

Source: Prepared by the authors.

Therefore, the simple aqueous solution allows for greater oxidation of ascorbic acid in the different types of fruits used in the experiment compared to the solution containing natural fruit juice. The oxidation rate, however, is more accentuated at the end of the experiment, using orange and acerola, compared to cashew nuts.

IV. CONCLUSIONS

The present study allowed to conclude that:

- all the juices used in the experiment (orange, acerola and cashew), in simple aqueous solutions, failed very quickly when compared to samples in solution of natural fruit juices.

- There is a presence of natural antioxidants in fruits that prevent the oxidation of ascorbic acid in dehydroascorbic acid as fast as its oxidation in its pure form, ie without the action of these natural antioxidants.
- acerola juice had a higher ascorbic acid content, and demonstrated a higher failure rate (ascorbic acid oxidation) during the 150 minutes of the experiment, indicating that there is a greater antioxidant "protection" of vitamin C in orange and cashew juice in relation to acerola juice.
- the characterization of these natural antioxidants in orange, cashew and acerola is proposed in future studies, considering the ability to retard the rate of

oxidation of ascorbic acid in order to attenuate the harmful effects of oxidative stress intrinsic to our body's metabolic activities.

REFERENCES

- [1] BIANCHI, M. L. P.; ANTUNES, L. M. G. Radicais Livres e os Principais Antioxidantes da Dieta. **Revista de Nutrição**. v.12, n.2, p.123-130, 1999.
- [2] BRITTO, D.; MOURA, M. R.; AOUADA, F. A.; MATOSSO, L. H. C.; ASSIS, O. B. G. N,N,N-Trimethylchitoson nananoparticles as a vitamin carrier system. **Food Hydrocolloids**. v.27, n.4, p. 487-493, 2012.
- [3] FERNANDES, J. I. M.; SAKAMOTO, M. I.; PEITER, D. C.; GOTTARDO, E. T.; TELLINI, C. Relação vitamina E: vitamina C sobre a qualidade da carne de frangos submetidos ao estresse pré-abate. **Arq. Bras. Med. Vet. Zootec**. v.65, n.1, p. 294-300, 2013.
- [4] GIESBRECHT, F.; KEMPTHORNE, A. H. Maximum Likelihood Estimation in the Three-parameter Lognormal Distribution. **Journal of the Royal Statistical Society B** 38, p. 257-264. 1966.
- [5] KLIMCKAC, J. G. K.; PATIL, B. S. In vitro evaluation of the antioxidant activities in fruit extracts from citron and blood orange. **Food Chemistry**. v. 101, n. 1, p. 410-418, 2007.
- [6] MEEKER, W. Q.; ESCOBAR, L. A. **Statistical Methods for Reliability Data**. John Wiley & Sons, Inc. 1998. 712p.
- [7] PICHHI, M. G.; DEMINICE, R.; OVÍDIO, P. P.; JORDÃO, A.A. Efeitos do ácido ascórbico nos biomarcadores de estresse oxidativo em nadadores de elite. **Rev. Bras. Med. Esporte**. v.19, n.6, p. 394-398, 2013.
- [8] RIGDON, S. E.; BASU, A. P. **Statistical Methods for the Reliability of Repairable Systems**. John Wiley & Sons. 2000. 290p.
- [9] ROCHA, M. S.; FIGUEIREDO, R. W.; ARAÚJO, M. A. M.; MOREIRA-ARAÚJO, R. S. R. Caracterização físico-química e atividade antioxidante (in vitro) de frutos do cerrado piauiense. **Rev. Bras. Frutic**. v. 35, n. 4, p. 933-941, 2013.

Leguminosae: Biodiversity and Taxonomy for the Northeast Region of Brazil

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Abstract— *The research aimed to know the diversity of Leguminosae in vegetational fragments of Cerrado in the state of Maranhão. Monthly expeditions were carried out in the period between September from 2016 and June 2017 for observation, collection, and identification of botanical material. A total of 68 specimens, 31 genera, and 45 species were cataloged. Of all the specimens collected, the subfamilies Papilionoideae and Caesalpinoideae were the most representative of 21 species each. As for the Life form, was observed that the prevailing growth habit was the bush type (20). Concerning to the physiognomies of the Cerrado, was observed the predominance of the species in the gallery forest environment (28). Taxonomic keys, descriptions and photo plates were elaborated with all the studied species, composing a taxonomic treatment. In this way, it can be established that the Cerrado of Maranhão possesses a diversity of species for the Leguminosae family and that the research carried out has provided a basis for later studies, since these are few for Maranhão.*

Keywords— *Shrubs, Cerrado, Floristic, Papilionoideae, Vigna lasiocarpa.*

I. INTRODUCTION

Within the large diversity of angiosperms, Leguminosae is one of the largest botanical families, with 770 genera and 19.500 species (LEWIS et al., 2005, 2013, LPWG, 2017) and divided into six subfamilies (Caesalpinoideae, Cercidoideae, Detarioideae, Dialioideae, Duparquetioideae, and Papilionoideae) (LPWG, 2017). In Brazil, there are 2.837 species (1.535 endemics) grouped in 222 genera (FLORA DO BRASIL 2020. 2019).

Leguminosae is a family of great economic importance being nourishing cultures important which provides high nourish sources of proteins and micronutrients that can profit the health and the ways of subsistence, especially the developing countries. (GRAHAM & VANCE 2003; YAHARA et al., 2013). Taking up the importance of ecological, are organism good adapted to first colonization an exploration of the several environments, changeovers incurred by the

association of fixative bacteria of nitrogen or with ectomycorrhiza.

The Cerrado has more than 4.800 species of endemic plants and vertebrates, being considered as a global biodiversity *hotspot*. This phytogeographical domain covers three of the largest hydrographic basins in South America, accounting for 43% of Brazil's surface waters outside the Amazon Rainforest (STRASSBURG et al., 2017). Due to its considerable biodiversity, this phytogeographical domain has been the focus of several botanical studies, and therefore, work on the Leguminosae family in the Cerrado is necessary due to its floristic richness (BATALHA, 2011), in addition to the fact that this Phytogeographical Domain is endangered of extinction (STRASSBURG et al., 2017). In the state of Maranhão, there is an ecotone with the Amazon Rainforest and Caatinga (MARANHÃO, 2011). In Maranhão, the São João do Soter City, it is on this

phytogeographic domain, possessing fragments not touched by man, conserving its biodiversity.

The state of Maranhão has large extensions of the Cerrado, with forest formations of significant extensions (standing out deciduous rainforests and, to a lesser extent, dense ombrophilous forests), as well as a large area of ecological tension with the Amazon Rainforest Phytogeographical Domain (MARANHÃO, 2011).

Thus, the research had as objective to know the diversity of Leguminosae in vegetative fragments of Cerrado in the state of Maranhão, specifying: to demonstrate the morphological aspects of the family Leguminosae; to elaborate taxonomic keys for the species studied; to determine the types of growth habits,

phytogeographic domains and environments of occurrence of the species and contribute to the knowledge of the flora Cerrado from Maranhão.

II. MATERIAL AND METHODS

Location and Characterization of the Study Area

The municipality of São João do Sóter (5 ° 6 '28' 'S. and 43 ° 48' 34 "W), located in Maranhão, carry over 1.438.1 km² and has 17,238 inhabitants in the last census. The population density is 11.9 inhabitants per km² in the municipality territory Located at 108 meters altitude. In the Municipality, three cerrado areas were sampled: Pedras Village, Redondo Village, and Serra do Cajú Village (IBGE, 2010).

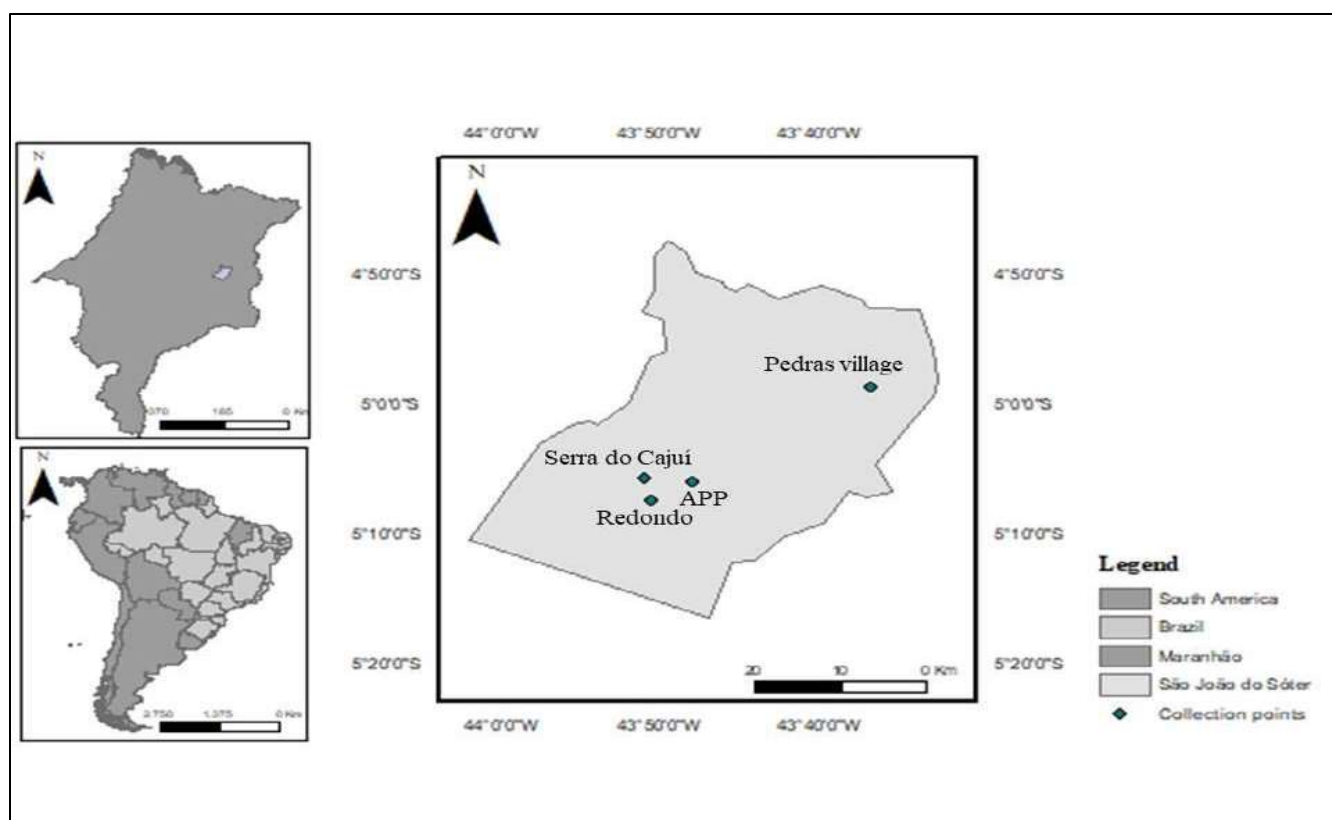


Fig.1: Map of the Municipality of São João do Sóter, Maranhão/Brazil, Collection area of the species of Leguminosae.
Source: IBGE; 2006, Google Earth 2014.

The vegetational fragments sampled are composed of physiognomies of galleries forest, coconut forest and dirty cerrado of herbaceous and perennial plants. The floristic survey comprised three stages: fieldwork, preparation and analysis, and identification of collected material. The collection of the botanical material was carried out from September 2016 to June 2017, through the active search method, with a monthly visit in the study area, comprising the dry and rainy months.

In the fieldwork, the specimens were collected in the fertile state, following the protocol Bononi; Fidalgo (1989). In the preparation of the botanical material, it was herborized and processed, being conditioned as exsiccates in Aluzio Bittencourt Herbarium (HABIT), State University of Maranhão/UEMA. In the identification stage, the specimens were recognized at the species level taking into account the comparison with the specialized material, specific bibliographies (LPWG, 2017),

taxonomic keys, and/or determined and confirmed by a family taxonomist. For the taxonomic treatment, all information and morphological characteristics of each species were observed and recorded. These characteristics formed a description of the plant along with the information of the author of the species, main work, geographical distribution and phytogeographical domains where the species occurs in the Brazilian territory. For the data of the author and main work of all species, was used the Tropicos (2019) (<https://www.tropicos.org/>); and SpeciesLink, CRIA (2019) (<http://www.splink.org.br/>). With the botanical description, dichotomous taxonomic keys of the described species were elaborated, using the taxonomic criteria already presented in the botanical description that better identifies the studied species.

III. RESULTS AND DISCUSSION

Taking into account floristic aspects, Leguminosae is one of the families among the angiosperms that have the richest species in the different phytogeographic domains of Brazil according to Queiroz (2009); Flora do Brasil 2020 (2019). From the obtained data were listed 68 specimens, distributed in 31, genera and 45 species. The representation of species of the Leguminosae subfamilies sampled in this research shows that of the 68 specimens studied, 21 species belong to the subfamily Papilionoideae, 21 belong to the subfamily Caesalpinioideae, 2 species belong to the subfamily Cercidoideae and 1 species belongs to the subfamily Detarioideae, as shown in table.

As for species richness, the subfamilies Papilionoideae and Caesalpinioideae were the most representative, sampled 21 and 19 species respectively (table.1). Papilionoideae is a monophyletic subfamily, with high reliability of phylogenetic reconstruction. The subfamily includes many species of economic importance (TOZZI, 2016). Caesalpinioideae in its present circumscription contains 148 genera and 4.400 species. With pantropical distribution, being common in dewy and dry regions, with a handful of species that extend to the temperate zone (LPWG, 2017). In terms of Brazil distribution, is represented by about 52 genera and 810 species (FLORA DO BRASIL 2020. 2019).

In the physiognomy of occurrence, the specimens were collected, mainly in gallery forests, with 28 species,

Clean Field 7 and Open field 6. Among the plant formations of the Cerrado, the gallery forest, also known as riparian forest or riparian forest by some researchers, is characterized by being associated with watercourses, and this formation, although small, possesses richness, genetic diversity, and acts in the protection of water resources (RIBEIRO, 1998). The two most representative genera in the survey were *Aeschynomene* and *Mimosa* with four species each.

The genus *Aeschynomene* L. has a pantropical distribution, with about 180 species (LEWIS et al., 2005). *Mimosa* L. comprises 540 species, being the second largest genus of the mimosoid clade (SIMON et al., 2011). It is distributed mainly in the neotropical region, counting on approximately 496 endemic taxa of the neotropics and 40 native species of the old world (SIMON et al., 2011; BARNEBY, 1991).

Regarding the life-form, was observed that the predominant habit of growth was the Shrub type with 18 species, after Tree 14 and herb 13. The life-form this family is assorted, from trees, shrubs, sub-bushes to upright herbs, creeping or even climbing (JUDD et al., 1999). Shrubs are characterized by woody structures of varying size, but not more than 6 m in height, and stem with branches much close to the ground (ORMOND, 2006). The bushes are outreached of woody plants, in which the support and stem tissues form layers that are added year after year (BONONI; FIDALGO, 1989).

As for the number of specimens of each species, the species *Phanera variegata* (L.) Benth., *Aeschynomene histrix* Poir., *Libidibia ferrea* (Mart. Ex Tul.) L.P. Queiroz and *Chamaecrista flexuosa* (L.) Greene. were the most representative in the survey, being *P. variegata* the most representative with 5 specimens, and the other 3 specimens each. *P. variegata* is planted in the tropics and hot regions of the world (ISELY, 1990). *P. variegata* is distributed in Amazon Rainforest phytogeographical domain, is found in Colombia, French Guiana and Suriname. In Brazil, it is native throughout the North Region, in the State of Maranhão and Atlantic Rainforest, in the São Paulo State (DOMINGOS, CARPELARI JR, 2016).

Table: Representation of Leguminosae species within each subfamily and Phytogeographical Domains sampled.

°	Subfamily	Species	Phytogeographical Domains
1.		<i>Caesalpinia pulcherrima</i> (L.) Sw.	Amazon Rainforest, Cerrado, Atlantic Rainforest
2.		<i>Cenostigma macrophyllum</i> Tul.	Amazon Rainforest, Caatinga, Cerrado

3.		<i>Chamaecrista flexuosa</i> (L.) Greene.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pampa, Pantanal
4.	CAESALPINIOIDEAE	<i>Chamaecrista nictitans</i> (L.) Moench.	Amazônia, Caatinga, Cerrado, Atlantic Rainforest, Pantanal
5.		<i>Chamaecrista rotundifolia</i> (Pers.) Greene.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pampa, Pantanal
6.		<i>Delonix regia</i> (Bojer ex Hook.) Raf.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pantanal
7.		<i>Dimorphandra gardneriana</i> Tul.	Caatinga, Cerrado
8.		<i>Inga edulis</i> Mart.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
9.		<i>Inga thibaudiana</i> DC.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
10.		<i>Mimosa caesalpinifolia</i> Benth.	Amazônia, Caatinga, Cerrado, Atlantic Rainforest
11.		<i>Mimosa pudica</i> L.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
12.		<i>Mimosa sensitiva</i> L.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
13.		<i>Mimosa xanthocentra</i> Mart.	Amazon Rainforest, Cerrado, Atlantic Rainforest
14.		<i>Parkia platycephala</i> Benth.	Amazon Rainforest, Caatinga, Cerrado
15.		<i>Stryphnodendron adstringens</i> (Mart.) Coville.	Caatinga, Cerrado
16.		<i>Libidibia ferrea</i> (Mart. ex Tul.) L.P Queiroz	Caatinga, Cerrado, Atlantic Rainforest
17.		<i>Plathymenia reticulata</i> Benth.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
18.		<i>Senna multijuga</i> (Rich.) H.S. Irwin & Barneby.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
19.	<i>Senna reticulata</i> (Willd.) H.S. Irwin & Barneby.	Amazon Rainforest, Caatinga, Cerrado	
20.	<i>Bauhinia dubia</i> G. Don.	Amazon Rainforest, Cerrado	
21.	CERCIDOIDEAE	<i>Bauhinia pulchella</i> Benth.	Amazon Rainforest, Caatinga, Cerrado
22.		<i>Phanera variegata</i> (L.) Benth.	Amazon Rainforest, Cerrado
23.	DETARIOIDEAE	<i>Tamarindus indica</i> L.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
24.		<i>Hymenaea stigonocarpa</i> Mart. ex Hayne.	Amazon Rainforest, Caatinga, Cerrado, Pantanal
25.		<i>Abrus fruticulosus</i> Wight & Arn.	Amazon Rainforest, Cerrado
26.		<i>Aeschynomene brasiliiana</i> (Poir.) DC.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pantanal
27.		PAPILIONOIDEAE	<i>Aeschynomene histrix</i> Poir.
28.		<i>Aeschynomene paniculata</i> Willd. ex Vogel	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pantanal
29.		<i>Aeschynomene viscidula</i> Michx.	Caatinga, Cerrado, Atlantic Rainforest
30.		<i>Centrosema brasiliiana</i> (L.) Benth.	Amazônia, Caatinga, Cerrado, Atlantic Rainforest, Pantanal
31.		<i>Clitoria guianensis</i> (Aubl.) Benth.	Amazon Rainforest, Caatinga, Cerrado, Atlantic

		Rainforest, Pantanal
32.	<i>Crotalaria retusa</i> L.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pampa.
33.	<i>Crotalaria stipularia</i> Desv.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pantanal
34.	<i>Desmodium barbatum</i> (L.) Benth.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pampa, Pantanal
35.	<i>Desmodium incanum</i> (Sw.) DC.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pampa, Pantanal
36.	<i>Desmodium subsecundum</i> Vogel.	Amazon Rainforest, Cerrado, Atlantic Rainforest
37.	<i>Dioclea bicolor</i> Benth.	Amazon Rainforest, Caatinga, Cerrado
38.	<i>Galactia jussiaeana</i> Kunth.	Amazon Rainforest, Caatinga, Cerrado
39.	<i>Indigofera suffruticosa</i> Mill.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
40.	<i>Macropodium atropurpureum</i> (Sessé & Moc. ex DC.) Urb.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pantanal
41.	<i>Macropodium lathyroides</i> (L.) Urb.	Amazon Rainforest, Cerrado, Atlantic Rainforest, Pantanal
42.	<i>Periandra heterophylla</i> Benth.	Amazon Rainforest, Cerrado
43.	<i>Phaseolus vulgaris</i> L.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
44.	<i>Stylosanthes viscosa</i> (L.) Sw.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pampa, Pantanal
45.	<i>Vigna lasiocarpa</i> (Mart. ex Benth.) Verdc.	Amazon Rainforest, Cerrado, Atlantic Rainforest, Pantanal

Key of Subfamily Caesalpinioideae

1. Herbs, shrub or tree with leaves always bipinnate with inflorescence of the glomerulus or raceme type.....2
 2. Trees with more than 10 m, always woody stem.....3
 3. Puberulent rusty branches, a lower crown, 30-45 leaflets per leaf, the apex of the rounded leaflet, a leaflet with 0.4 x 0.1 cm1 *Stryphnodendron adstrigens*
 3. Grayish, not pubertal branches, high crown, 35-50 leaflets per leaf, the apex of the acute leaflet, a leaflet with 0.6 x 0.2 cm2 *Parkia platycephala*
 2. Herbs or sub-shrub less than 10 m high, woody or herbaceous stem.....4
 4. Individuals < 1m in height, small leaflets < 1cm and < 0.5cm in width.....5
 5. Symmetrical lanceolate leaflets, dry fruit type crusty, 1.5 cm x 0.3 cm3 *Mimosa pudica*
 5. Leaflets oblong-lanceolate, fruit vegetable dry with indumentum, indiscriminate, with 9 x 0.3cm.....4 *Mimosa xanthocentra*
 4. Individuals > 1m, large leaflets larger > 1cm and > 0.5cm of width 6
 6. Leaflets tetrafoliolates, asymmetric, 2 pairs of leaflets for leaf, dry fruit of the type craspedium, with approximately 2,5x 0.3 cm.....5 *Mimosa sensitiva*
 6. Leaflets bipinnates, symmetrical, with 6-12 pairs of leaflets per leaf, legume fruit, with 5x0.3cm6 *Mimosa caesalpiniiifolia*
1. Herb, shrub, or trees with leaves bipinnates or imparipinnates with inflorescences type raceme, never glomerulus.....7
 7. Tree or shrub, with woody stem.....8

8. Trees with pubertal branches.....9
9. Stipules rudimentary or without the presence of nectary, fruit of the legume type with falcate apex.....7*Cenostigma macrophyllum*
9. Sticks not rudimentary or with the presence of nectary, legume fruit without falcate apex.....10
10. Winged petiole with petiole nectary.....11
11. Nectary greater than 2mm rounded longitudinal at the base of the rachis petioles.....8*Inga edulis*
11. Nectary less than 2mm rounded not longitudinal at the base of the rachis petiole.....9*Inga thibaudiana*
10. Absence of winged petiole, absence of nectary petiole.....12
12. Presence of long stipules in the shape of an orange sickle, with leaflets 10 x4.2 cm10*Senna reticulata*
12. Presence of small elongated stipules, leaflets 6.7 x2.6 cm11*Senna multijuga*
8. Trees with glabrous branches a little puberulent.....13
13. Inflorescence raceme with red or yellow flowers.....14
14. Flowers with red petals, lush banner, legume with 10 cm.....12*Delonix regia*
14. Flowers with yellow petals with reddish banner.....13*Libidibia ferrea*
13. Inflorescence not raceme with green or white flowers.....15
15. Inflorescence with >10 racemes, green with the presence of stamens and staminoids.....14*Dimorphandra gardneriana*
15. Inflorescence with <10 racemes, white without the presence of stamens and staminoids.....15*Plathymenia reticulata*
7. Subshrub or grass herb.....16
16. Presence of aculeus in the branches, showy red flowers, legume fruit with long apex.....16*Caesalpinia pulcherrima*
16. Absence of aculeus in the branches, exuberant flowers, legume fruit without long apex.....17
17. Prostrate growth, bipinnate leaves, legume fruit with 2-3 items.....17*Chamaecrista nictitans*
17. Growth creep or erect decumbent, bifoliolate leaves, legume fruit >3 items.....19
18. Creeping growth leaflets 3.2 x 3 cm, linear fruit with 2.2 cm and fruit petiole extended with 1.5 cm.....18*Chamaecrista rotundifolia*
18. Decumbent erect growth, leaflets with 4 x 1.2 cm, a linear legume fruit type of 4.5 cm with fruit petiole not very extended with 0.5 cm19*Chamaecrista flexuosa*

Description of Subfamily Caesalpinioideae

1. *Stryphnodendron adstringens* (Mart.) Coville (Century Dict.) 11: 111, 1910.

Description: Tree with woody trunk fissured with approximately 10 m of height, sympodial growth, branches blackish parts, absence of stipules, inermis, cylindrical, glabrescent branches, glandular trichomes in the branches with 0.3 x 0.4 cm, inches composites bipinnate leaves, alternating between 5.5 x 0.3 cm, deciduous, presence of 30-45 pairs of leaflets, leaflets with 0.4 x 0.1 cm, rounded apex, smooth margin, parallel-nerved vein, absent flower, absent fruit.

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23/VI/17, G. S. GOMES; G. M. CONCEIÇÃO, 43 (HABIT).

2. *Parkia platycephala* Benth. J. Bot. (Hooker) 4 (30): 329, 1841.

Description: Tree with woody stem, sympodial growth of tall crown with 15 m, grayish branches, abstract stipules, composite bipinnate leaves, presence of 35-50 pairs of leaflets, spiral alternate phyllotaxy, diminutive lanceolate leaflets, 6 x 0.2 cm, petiole with 7 cm, long leaves with 19.5 cm showing pulvinus, whole margin, acute leaf apex, penninerved vein, cuminous inflorescence, dry fruit type legume, with 10 x 2.5 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 4 (HABIT).

3. *Mimosa pudica* L. Gard. Dict. (Ed. 8) no. 4, 1768.

Description: Shrub with woody stem, 20 cm, aculeous in the form of sickle with 0,5 0.2 cm long, bipinnates composites leaves with 6-10 pairs of leaflets, 3,2 cm pinnae, phyllotaxy alternate distal, lanceolate leaflet, with 0.9 x 0.2 cm, 2.3 cm petiole, 3.9 cm leaf, whole margin, lanceolate leaf apex, paraleinnerved vein, glomerulus cymose inflorescence, dichlamydeous, heterochlamydeous, zygomorphic symmetry, polystemonous free stamens, pink color, fruit legume craspedium type, 1.5 cm long and 0.3 cm .

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO 42 (HABIT).

4. *Mimosa xanthocentra* Mart. Flora 21 (2, Biebl.): 50.1838.

Description: Subshrub with approximately 60 cm, woody stem, prostrate sympodial growth, inermous, cylindrical branches, aculeous of 0,2 x 0.2 cm, on the stem; stipules with 0.3 x 0.2 cm, triangular, alternate composite sheets with 2 x 0.4 cm, bipinnates, with 10-5 pairs of leaflets, petioles 0.2 cm, absent extraphleic nectaries; leaflets 0.7 x 0.4 cm, oblong-lanceolate, flower absent, legume fruit with indumentum, indescend, with 9 x 0.3 cm.

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 41 (HABIT).

5. *Mimosa Sensitiva* L. Sp. Pl. 1: 518, 1753.

Description: Shrub with 2 m, branched sympodial growth, woody stem, rudimentary aculeous branches present in every branch of the shrub with 0.2 x 0.1 cm, greenish branches, tetrafoliolate composites leaves, alternate phyllotaxy, asymmetrical leaflets, unbalanced, 2.6 x 1.0 cm, petiole with 3.0 x 5.6 cm, whole leaf margin, acute leaf apex, penninerved vein, cymose , spiky, white, flower absent, fruit craspedium type, with approximately 2,5 x 0.3 cm.

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 15, 39 (HABIT).

6. *Mimosa caesalpiniiifolia* Benth. (J. Bot. (Hooker) 4 (31): 392, 1841.

Description: Shrub with woody stem, with 3m, branched sympodial growth, prostrate, grayish branches to blackened form embira, aculeous in sickle were present with 0.8 x 0.2 cm. bipinnates composite leaves with 6-12 pairs of pinnae, alternate phyllotaxy, ovate leaflet, 2.6 x 1.6 cm, petiole with 0.2 cm, leaf approximately 8.0 cm,

whole margin, rounded leaf apex, penninerved grove, cumin-shaped, spiky inflorescence, white coloring, absent flower, legume fruit, with 5 x 0.3 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 13, 14 (HABIT). **Geographical Distribution:** North (Amazonas, Pará, Rondônia); Northeast (Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte); Center-West (Federal District, Goiás, Mato Grosso do Sul); Southeast (Espírito Santo, Minas Gerais, Rio de Janeiro, São Paulo); South (Paraná, Santa Catarina) (FLORA DO BRASIL 2020. 2019). **Phytogeographical Domain:** Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest (FLORA DO BRASIL 2020. 2019).

7. *Cenostigma macrophyllum* Tul. Ann. Sci. Nat., Bot., Ser. 2, 20: 141, pl. 3, 1843.

Description: Tree with woody stem with approximately 10m of height, sympodial growth; rudimentary stipules present with 0.3 cm , with puberulent garments; petiole with approximately 3.0 x 0.4 cm; bipinnates composite leaves with 5-8 pairs of leaflets, alternate phyllotaxy, absence of nectaries, 13 cm; ovate leaflets, 9.7 x 2.6 cm, whole leaf margin, mucronate leaf apex; flower absent and cymose inflorescence with floral buds with 0.9 cm of ; fruit of the fallow legume type, 12.7 x 1.2 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 27 (HABIT).

8. *Inga edulis* Mart. Flora 20 (2, Beibl.): 113-114, 1837.

Description: Trees of 7 m, sympodial growth of low branch, woody stem, branches with attached structures, tomentose stipules, cylindrical pebbles of 0,2 x 0,2 cm. winged deciduous, bipinnates composite leaves, with 3-8 pairs of leaflets, smooth margin, acute apex, penninerved vein, petioles with 0.4 x 0.2cm, petiolate with 13.5 x 8 cm. winged leaf 4.6 cm, nectary leaves of 0.1 cm. an d 0.1 of width. broad, concave, sessile in the circular shaped stem, absent flowers, and absent fruits. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 37, 38 (HABIT).

9. *Senna reticulata* (Willd.) H. S. Irwin & Barneby. Mem. New York Bot. Gard. 35: 458, 1982.

Description: Tree with woody stem, approximately 5m high, sympodial growth, puberulent blackish branches, sickle type stipules, orange, present with 0.8 x 0.3 cm,

composite leaves with 15-20 pairs of pinnae, spiral alternating phyllotaxy, oblong leaflets, 10 cm and 4.2 cm, petiole with 4.5 cm, leaf with approximately 18 cm, whole margin with emarginated leaf apex, penninerved vein, raceme inflorescence with several racemes produced, dioecious, complete, heterochlamydeous, dialystemonous, free stamens, fruit dehiscent legume, with 14 x 2.2 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Serra do Cajuí Village, 14 / II / 17, G. S. GOMES; G. M. CONCEIÇÃO, 22 (HABIT).

10. *Senna multijuga* (Rich.) H.S. Irwin & Barneby Mem. New York Bot. Gard. 35: 492, 1982.

Description: Tree with woody stem, 7m high with sympodial growth, with grayish parts about 10m, grayish branches, composite leaves, 8-12 pairs of pinnae, petiole with up to 2 cm of, and 0.9 cm, leaflets of 6.7 x 2.6 cm. petiolate, oblong, glabrous or puberulent tops, nectary 0.2 cm, the raceme spinal cord at the base of the petiole in the first jug; canaliculate petiole with 0.2 x 0.1, yellow dioecious flower, complete (sepals and petals), dichlamydeous, heterochlamydeous, dialystemonous, free stamens, absent fruit. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 25, 26 (HABIT).

11. *Dimorphandra gardneriana* Tul. Arch. Mus. Hist. Nat., 4: 185, 1844.

Description: Tree with stem trunk with 12m long, sympodial growth, woody stem, shape embira, obtipate stipules, composite leaves with 30 x 14 cm, bipinnates, opposite phyllotaxy, oblong leaflet shape, with 1.8 x 1.0 cm, presents about 15-25 pairs of leaflet, whole leaf margin, rounded leaf apex, truncated base, diminutive petiole with approximately 0.2 cm of, raceme inflorescence, with approximately 10 racemes, with approximately 10 x 3 cm, shows a light greenish color with a crescent, showing stamens and tiny staminoids, absent fruit. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 32, 33 (HABIT).

12. *Plathymania reticulata* Benth. J. Bot. (Hooker) 4 (30): 334, 1841.

Description: Tree with woody stem, sympodial growth, 12 m, form embira, abstract stipules, absent nectary, leaves composed of approximately 20-30 pairs of leaflets, bipinnates with pulvinus, alternate Phyllotaxy, oblong

leaflet, 2 x 0.6 cm, petiole with 3.0 cm, long leaves with 14 cm, whole margin, emarginated leaf apex, penninerved vein, raceme inflorescence approximately 4 x 0.3 cm, single racemes, miniature white flowers, absent fruit.

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area; Redondo Village; Populated Stones, 08 / X / 16; 13 / II / 2016; 23 / VI / 2017, G. S. GOMES; G. M. CONCEIÇÃO, 16, 24, 68 (HABIT).

13. *Delonix regia* (Bojer ex Hook.) Raf. Fl. Tellur. 2: 92, 1836 [1837].

Description: Tree with sympodial growth, woody stem, approximately 15m, shape embira, obtipate stipules, composite bipinnates leaves with 30 x 15 cm, alternate Phyllotaxy, oblong leaflet shape, with 30-50 pairs of leaflets, with 0.7 x 0.2 cm, rounded apex, smooth margin, symmetrical base, petiole with 2.5 x 0.4 cm, petiole with 0.3 x 0.1 cm, absent flower, fruit of the dehiscent type, with 15 x 3 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 40 (HABIT).

14. *Libidibia ferrea* (Mart. Ex Tul.) LP Queiroz Legum. Caatinga 130, 2009.

Description: Tree with woody stem, 5m high, sympodial growth, absent stipules, puberulent branches rusty, bipinnates composite leaves with approximately 10-15 pairs of leaflets, alternate phyllotaxy, leaflets oblong, with 3.6 x 1.0 cm, petiole with 1.1 x 0.3 cm, leaf with approximately 6.5 cm, whole leaf margin, rounded leaf apex, penninerved vein, glabrous leaflets, indeterminate inflorescence, flower with approximately 1.0 x 0.5 cm, yellow flowers, complete, dichlamydeous, heterochlamydeous, showy standard, dialystemonous, legume fruit dry type, with 7.3 x 2.0 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 28, 29, 30 (HABIT).

15. *Caesalpinia pulcherrima* (L.) Sw. Observ. Bot. 166, 1791.

Description: Woody trunk tree, 4 m, shows sympodial growth, presence of aculeus in the trunk with 0.4 x 0.2 cm, composite leaves bipinnates with 5 pairs of pinnae, 30 cm, phyllotaxy alternates, without stipules, petiole with 0.5 x 0.3 cm, green leaflets of 7-11 pairs, with 6.1 x 3.4 cm, red flower with long stamens of 4 cm. zygomorphic symmetry. legume fruit dry type with 9.3 x 2.5 cm. **Material Examined:** BRAZIL. MARANHÃO:

São João do Sóter, Pedras Village, 13 / II / 17, G. S. GOMES; G. M. CONCEIÇÃO, 31 (HABIT).

16. *Inga thibaudiana* DC. Prodr. 2: 434-435, 1825.

Description: Shrub with 3 m, woody stem, sympodial growth, with cylindrical root, presents indumentum in the branches, form embira, compound leaves with 11,1 x 9.5 cm, with 3 to 8 pairs of leaflets, alternating leaflets with 4.9 x 3.8 cm. The larvae are broad and narrow in the abaxial surface, with a smooth margin, penninerved vein, petiole with tiny extraphalic nectaries, at the base of the leaflets, with a rounded nectary, fruit absent. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 34, 35 (HABIT).

17. *Chamaecrista nictitans* (L.) Moench. Methodus 272, 1794.

Description: Herb with approximately 40 cm, herbaceous stem, prostrate growth, branches of 28 x 16.5 cm. stipules on the petiole with approximately 0.4 x 1 cm. composite leaves, bipinnates, oblong leaflets of approximately 0.1 x 0.1 cm. rachis with 0.3 cm. absent flower and legume fruit with 3.5 x 0.3 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 58 (HABIT).

18. *Chamaecrista rotundifolia* (Pers.) Greene. Pittonia 4 (20D): 31, 1899.

Key of Subfamily Cercidoideae

- 1 Grass or shrubs with grampiform branches scandante, single leaves with split limb.....**1Phanera variegata**
 1 Grass, shrub or tree without grampiform branches, single leaves with or without split limb..... 2
 2. Bilobed simple leaf, small 3.5 cm, 2.6 cm, legume fruit type, 6 cm long, 2 cm**2Bauhinia pulchella**
 2. Single cordiform leaf, uncut in limbus, large 7.5 x4.3 cm; legume fruit with 14,5 x 1,5cm**3Bauhinia dubia**

Description of Subfamily Cercidoideae

1. *Phanera variegata* (L.) Benth. Pl. Jungh. 2: 262, 1852.

Description: Shrub with approximately 2 m, sympodial growth, woody stem, blackened branches, leaves with tinystipules to absent, single leaves with 7,0 x 4.6 cm, bilobate simple leaflets, rounded apex, petiole with 4.3 cm x 0.8 cm phyllotaxy alternate, vein cunninerved, absence of nectarines, presence of grampiform branches, scandants with approximately 6x 0.3 cm, absent flower and absent fruits. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area; Redondo Village; Pedras Village, 08 / X / 16; 13 /

II / 2016; 23 / VI / 2017, G. S. GOMES; G. M. CONCEIÇÃO, 2, 3, 20, 21, 36 (HABIT).

Description: Herb stem, triangular stipules present with 0.1 x 0.2 cm. bifoliate composite leaves, alternate phyllotaxy, 3.2 cm obovate leaf, and 3 cm, whole leaf margin, obtuse apex, yellow zygomorphic flower, achlamydeous, legume fruit dry type with 2.2 cm and fruit petiole extended with 1.5 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 66 (HABIT).

19. *Chamaecrista flexuosa* (L.) Greene Pittonia 4 (20D): 27, 1899.

Description: Shrubs with woody stem, erect to decumbent growth, approximately 20 cm, perennial, erect, with triangular stipules of 5 x 3.2 cm, bilobate leaves with 4cm of. leaflets, with 5 to 10 pairs, with 4 x 1,2 cm long, extrafollicular nectary leaflets linear-lanceolate to linear-oblong or closely oblong-elliptic, straight to slightly distally falcate, persistent, heteromorphic and asymmetric stipules, lanceolate acuminate or ovate-acuminate, absent flower, legume fruit with 4.5 x 0.5 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 48, 49, 50 (HABIT).

2. *Bauhinia pulchella* Benth. Fl. Bras. 15 (2): 190, 1870.

Description: Shrub with woody stem, approximately 3m, with sympodial growth, presents rudimentary stipules with 0.3cm of, branches glabrous; petiole with 0.6 x 0.2 cm, single sheets, 6.0 x4.3 cm, spiral alternating phyllotaxy, absence of nectary; leaflet with bilobate limb, 3.5 x 2.6 cm, whole margin, rounded leaf apex; inflorescence cyanotic, monoecious, dichlamydeous, heterochlamydeous, zygomorphic, calice gamosepalous, with 1.0cm, glabrous, linear peduncle; corolla linear dialypetalous with 1,5 x 2,5 cm, free stamens; dried legume fruit type, with 6,0 x 2,0 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Redondo Village, 13 / II / 17, G. S. GOMES; G. M. CONCEIÇÃO, 17 (HABIT).

3. *Bauhinia dubia* G. Don Gen. Hist. 2: 463, 1832.

Description: Shrub with woody stem of sympodial growth with approximately 3m , rudimentary stipules present with 0.2 cm ; glabrous branch; petiole of 4 cm long and 0.2 cm ; sheet 7.5 x 4.3 cm width, alternate phyllotaxy, absence of nectaries; simple leaflets

cordiform to sagittate, 3.4 x 3.6 cm , cm, whole leaf margin, rounded apex; inflorescence raceme; floral bud with 0.8 x 2.5 cm , dried fruit, dehiscent legume type with 14.5 x 1.5 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Village Redondo 13 / II / 17, G. S. GOMES; G. M. CONCEIÇÃO, 23 (HABIT).

Key of Subfamily Detarioideae

1. Composite bipinnates leaves, presents 28 to 40 pairs of leaflets, alternating phyllotaxy.....**1Tamarindus indica**
1. Composite bifoliolate leaves, not dystonic alternate phyllotaxy.....**2Hymenaea stigonocarpa**

1. *Tamarindus indica* L. (Sp. Pl.)1: 34, 1753.

Description: Tree with 12 m , woody stem, symmetrical growth, high crown, brownish branches, rudimentary stipules present with 0.2 cm, composite leaves bipinnates, presents 28 to 40 pairs of leaflets, oblong leaflet with 1.0 x 0.3 cm , petiole with 3.0 cm leaf with approximately 8.0 cm , whole leaf margin, rounded leaf apex, paraleinnerved vein, flower absent, absent fruit. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 5 (HABIT).

Description: Tree with 15m height, woody stem, elongated sympodial growth, glabrous branches, bifoliolate composite leaves, alternate phyllotaxy, asymmetrical leaflet form ovate, without indumentum, leaflet with 11 x 5cm , petiole with 2.0 cm, leaf with 8.0 cm, presence of leaf blade limbs, whole margin, emarginated leaf apex, penninerved veins to cunninerved, absent flower, legume fruit dry type, with approximately 7.0 x 4 cm .**Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Redondo Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 19 (HABIT).

2. *Hymenaea stigonocarpa* Mart. Getreue Darstell. Gew. 11: sub pl. 13, 1830.

Key of Subfamily Papilionoideae

1. Liana, fruit type vegetable with 3 seeds, without forming of articles, with 4 cm, margin revolute of legume.....**1Dioclea bicolor**
1. Herb or Subshrub, legume fruit with 3 more seeds or with the formation of articles, without revolute margin..... 2
 2. Subshrub with height equal to or greater than 1m, only erect growth3
 3. Composite leaves imparipinnates, with 8 to 12 pairs of leaflets, fruit legume type curved, forming in bunches in the main branch, with 8,0 cm of**2Indigoferasuffruticosa**
 3. Leaves simple or trifoliolate, fruit legume lomentum type, not form clusters in the main branch..... 4
 4. Leaves simple large ovate, with 20 x 10 cm long, long fruit forming branches, arranged alternately.....**3Desmodium subsecundum**
 4. Small trifoliolate leaves, small fruit forming branches, arranged not alternate leaves form.....5
 5. Elliptic leaflets, 2.4 x 1.1 cm, fruit type lomentum, 1.1 cm, with 3-5 articles.....**4Desmodium incanum**
 5. Elliptic leaflets, 7 x 3.6 cm, fruit type lomentum, 3.3 x0.8 cm, has 3-6 items dressed.....**5Desmodium barbatum**
 2. Climbing or herbaceous herb with height equal to or >1,5m, erect, decumbent or prostrate growth.....6
 6. Decoding growth climbing herbs.....7
 7. Leaves composed of 8-15 pairs of leaflets, bipinnates with 2.3 x 0.9 cm, pseudo-raceme inflorescence.....**6 Abrus fruticulosus**
 7. Leaves trifoliolate, inflorescence raceme or cymose, not raceme.....8
 8. Long lanceolate leaflet..... 9

9. Leaflet with 5,2 x 3 cm long, papilionaceous flower, lilac dark to purple petals.....**7***Centrosema brasiliana*
9. Leaflets with 5,0 x 1,0 cm, papilionaceous flower petals light to whitish lilac.....**8***Clitoria guianensis*
8. Leaflets ovate or obovate..... 10
10. Leaflets ovate, with 10 x 6.1 cm, mucronate leaf apex, marked penninerved vein, red papilionaceous flower.....**9** *Periandra heterophylla*
10. Leaflets obovate 4.5 x 3 cm, acute leaf apex, unmarked penninerved vein, yellow papilionaceous flower.....**10***Vigna lasiocarpa*
6. Herbaceous herb of erect or prostrate growth..... 11
11. Simple leaves, legume fruit capsule type 12
12. Leaflet with 4.7 cm. and 2.0 cm long, winged petiole with 0.3 cm, fruit with 2.3 cm**11** *Crotalaria stipularia*
12. Leaflet with 4,2 x 1.5cm, not winged petiole with 0.3 cm, fruit with 3.0 cm**12***Crotalaria retusa*
11. Composite leaves, typical legume fruit or lomentum..... 13
13. Compound leaves bipinnates, legume lomentum..... 14
14. Leaflets with up to 6 pairs of pinnas, equal to or < 0,5cm, lomentum with up to 3 articles.....**13***Aeschynomene viscidula*
14. Leaflets with more than 6 pairs of pinnas, > 0.5 cm long, legume lomentum with more than 3 articles..... 15
15. Leaflets of the base of the pinna bigger than the apex, obovate, with a maximum of 12 pairs of pinnas.....**14***Aeschynomene brasiliana*
15. Leaflets of the base never greater than the one of the apex, oblong, with the maximum of more than 12 pairs of pinnas 16
16. Leaflets with 7,0 x 0.2 cm, apex acuminate, legume with up to 7 articles.....**15***Aeschynomene histrix*
16. Leaflets 1.0 cm long, 0.3 cm, rounded leaf apex, legume with up to 5 articles.....**16***Aeschynomene paniculata*
13. Composite leaves trifoliolate, fruit legume type..... 17
17. Leaf lobes lateral, leaflet equal to or > 4cm 18
18. Leaflets with 8cm, truncated rachis**17***Phaseolus vulgaris*
18. Leaflets, 4 cm, not truncated rachis..... 19
19. Lateral leaflets with diminutive petiole to sessile, fruit legume type with 6 cm, indehiscent.....**18***Macroptilium atropurpureum*
19. Side leaflets with elongated petiole, fruit legume type with 5.6cm of**19***Macroptilium lathyroides*
17. Not lobulated lateral leaflets, leaflet smaller than 4cm 20
20. Leaf apex emarginate, leaflet with 3x1.7cm.....**20***Galactia jussiaeana*
20. Acute leaf apex, a leaflet with 1.9 x 0.6cm, elliptical.....**21***Stylosanthes viscosa*

1. *Dioclea bicolor* Benth. (Comm. Legum. Gen.) 69, 1837.

Description: Liana with woody stem, presents approximately 2 m, erect growth, shape embira, present linear stipules with 0.6 cm, trifoliolate composite leaves, deistical alternate phyllotaxy, large oblong lanceolate leaflet with 8, 4 cm long and 5.0 cm, petiole with 4.6 cm, and leaf with approximately 13.1 cm, whole leaf margin, rounded leaf apex, penninerved vein, raceme inflorescence, fruit legume type, with 4 cm long, ridge,

hairy, with 2 to 5 seeds. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 10 (HABIT).

2. *Indigofera suffruticosa* Mill. Gard. Dict. (Ed. 8) *Indigofera* no. 2, 1768.

Description: Shrub with woody stem, 2m long, symmetrical erect growth, present linear stipules with 0.5 cm, unequipped composite leaves, with 8-12 pairs of

leaflets, alternate phyllotaxy, lanceolate-oblong leaflet, with 3.0 x 1.2 cm, petiole with 2.0 cm, leaf 9.3 cm, crenellated leaf margin, mucronate leaf apex, penninerved vein, symmetric leaflet, raceme Inflorescence, curved legume type dry fruit, forming in bunches in the main branch, with 8.0 cm, fruit with 1.5 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO 56 (HABIT).

3. *Desmodium subsecundum* Vogel. (Linnaea) 12: 99, 1838.

Description: Subshrub with approximately 1 m of height, erect growth, woody stem, triangular stipules with approximately 0.4 x 0.1 cm, single large ovate leaves with some 3.4 x 2 cm. others with 20 x 10 cm, trichomes on the stem of approximately 0.1 x 0.1 long, rather, 3 cm petiole. and 0.4 cm. rachis with 0.4 cm. whole margin, rounded apex, ovate leaflet, symmetrical, penninerved vein, absent flower, fruit legume type of approximately 0.1 x 0.1 cm. arranged alternately no petiole, having 3-5 articles with adherent trichomes. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 65 (HABIT).

4. *Desmodium incanum* (Sw.) DC. Prodr. 2: 332, 1825.

Description: Herbaceous subshrub, decumbent erect growth, is approximately 1m, triangular stipules present with 0.6 cm, basis of the petiole, composite trifoliolate leaf, alternating phyllotaxy, elliptic leaflets, 2.4 x 1.1 cm, 1.5 cm petiole, approximately 4.0 cm, leaf, whole leaf margin, apex rounded, symmetrical, penninerved vein, presence of trichomes, medium pilosity, inflorescence raceme, absent flower, dry fruit lomentum type, with 1,1 cm. Possessing 3-5 articles with adherent trichomes. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 51, 52 (HABIT).

5. *Desmodium barbatum* (L.) Benth. Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn 1853 (1-2): 18, 1853.

Description: Subshrub with 80 cm, woody stem, erect growth, triangular stipules present with 0.6 cm, composite leaves trifoliolates, phyllotaxy distal alternate, leaflets elliptic symmetrical, with 7 x 3,6 cm of width, petiole with 1.5 cm, leaf with approximately 4.0 cm, whole leaf margin, rounded apex, hairiness with whitish trichomes,

penninerved vein, raceme inflorescence, absent flower, dried fruit lomentum type, 3 x 0.8 cm, 3-6 items, clingy.

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 67 (HABIT).

6. *Abrus fruticulosus* Wight & Arn. (Prod. Fl. Ind. Orient.) 1: 236, 1834.

Description: Herb with approximately 1 m, with herbaceous stem, indumentum in the present branch. Persistent, tiny linear stipules at the base of the petiole, petiole with 3.5 x 2 cm; leaves composed of 8-15 pairs of leaflets, bipinnates with 2.3 x 0.9 cm, obovate, linear leaflets; legume, rounded apex, symmetrical limbus, Inflorescence: position of the pseudo-raceme inflorescence, flower absent, typical fruit with 3.5 x 1 cm. apex sharp to curved. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 57 (HABIT).

7. *Centrosema brasiliana* (L.) Benth. Comm. Legum. Gen. 54, 1837.

Description: Herb, herbaceous stem, approximately 1.5 m, presents triangular ocrea stipules at the base of the petiole of 0.3x0.2 cm, trifoliolate composite leaves, with an opposite pair at the base and one elongated by the rachis, 7 cm long leaf, alternate phyllotaxy, leaflets 5.2 x 3 cm lanceolate to linear, smooth margin, acute apex, penninerved vein, little evident trichomes, papilionaceous flower, purple petals, with heterochlamydeous axillary inflorescence, dichlamydeous, dialystemonous, complete, typical legume fruit 7,0 x 0.4 cm, linear. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area; Populated Stones, 08 / X / 16; 23 / VI / 2017, G. S. GOMES; G. M. CONCEIÇÃO, 9, 44, 45 (HABIT).

8. *Clitoria guianensis* (Aubl.) Benth. J. Proc. Linn. Soc., Bot. 2: 40, 1858.

Description: Herb, approximately 50 cm, herbaceous stem, ovate stipules, striated, at the base of the petiole with 0.3 x 0.1 cm, composite leaf trifoliolate with 5 x 1 cm, lanceolate leaflet, alternates phyllotaxy, acute apex, penninerved veins, symmetric, present trichomes, axillary inflorescence, flower, monoecious, subsessile; long tubular calyx whitish, striated, papilionaceous corolla, unguiculated petals, lilac, orbicular banner, lato; free wings, obovate, keel falcated, lato unguiculate, heterochlamydeous, dichlamydeous, dialystemonous, absent fruit. **Material Examined:** BRAZIL.

MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 60 (HABIT).

9. *Periandra heterophylla* Benth. (Comm. Legum. Gen.) 57,1837.

Description: Herbaceous, climbing vine, 1.20 m, decumbent erect growth, presence of linear stipules with 0.4 cm of , absence of nectary, composite leaves, trifoliolate, alternate , leaflet ovate-lanceolate, 10 x 6.1 cm , petiole with 5.0 cm, leaf with approximately 8.0 cm, whole margin, mucronate leaf apex, marked penninerved vein, symmetrical leaflet, presence of trichomes in leaflets and aramos, homogeneous pilosity, cymose inflorescence with 0.8 cm of , flower absent, fruit absent. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 53 (HABIT).

10. *Vigna lasiocarpa* (Mart.ex Benth.) Verdc. (Kew Bull.) 24 (3): 539.1970.

Description: Herb with approximately 30 cm, erect decumbent growth, herbaceous stem, greenish branches, triangular stipules 0,3x 0,1 cm at the base of the petiole. Leaves composite trifoliolate, alternate, adaxial structure with secondary penninerved vein marked in leaflets, leaflets obovate with 4.5 x 3 cm, acute leaf apex, petiole with 4 x 0,1 cm, full margin, symmetrical, presence of trichomes in leaflets, Inflorescence raceme, axial, yellow flower, zygomorph, achlamydeous, papilionaceous, dry fruit of the long legume type with 3 x 0.2 cm . with trichomes. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 63 (HABIT).

11. *Crotalaria stipularia* Desv. J. Bot. Agric. 3: 76, 1814.

Description: Herb stem-like stem herb, decumbent erect growth, 65cm long, linear stipules present with 0.3 x 0.1 cm, nectaries absent, single leaves, alternate phyllotaxy, leaflets oblong-lanceolate, with 4,7 x 2,0 cm, winged petiole with 0.3 cm, leaf approximately 5.1 x 3 cm , leaf margin whole, apex emarginate, penninerved vein, symmetric, presence of white trichomes, quite hairy, yellow papilionaceous flower with 0.3 x 0.3 inches. with zygomorphic symmetry inflorescence cymose, heterochlamydeous, dichlamydeous, dialystemonous, dry fruit, capsule, with approximately 2.3 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 47 (HABIT). 12.

12. *Crotalaria retusa* L. Sp. Pl. 2: 715, 1753.

Description: Herb stem-type herb, 50 cm high, decumbent erect growth, linear stipules present with 0.4 cm of , absent nectaries, single leaves, alternate phyllotaxy, obovate leaflets, 4.2 cm, bought 1.5 x 0.3 cm petiole, 4.6 cm long leaf and 4 cm , whole leaf margin, emarginated apex, penninerved vein, cuminous inflorescence, absent flower, dried fruit, capsule, with approximately 3.0 cm of , and 0.8 cm . with legume acute terminal. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 12 (HABIT).

13. *Aeschynomene viscidula* Mich. Fl. Bor.-Amer. 2: 74-75, 1803.

Description: Herb with approximately 50 cm of height, herbaceous stem, prostrate growth, branches with 32 x 19 cm, triangular stipules with 0.4 x 0.2cm, is found at the base of the petiole, composites bipinnates leaves, with 3-pairs of leaflets, leaflet with 1.7 x 1 cm , petiole 0.5 x 0.1 cm , obovate leaflets 0.5 x 0.6 cm , trichomes, flower with campanulate calyx, papilionaceous, yellow cream, showy standard, heterochlamydeous, dialystemonous, dialypetalous, Fruit type lomentum legume, with articles joined by isthmus with 1 x 0.3 cm , features 3 hairpieces. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 59 (HABIT).

14. *Aeschynomene brasiliiana* (Poir.) DC. Prodr. 2: 322, 1825.

Description: Herb with approximately 50 cm, woody stem, erect growth to decumbent, branches with gray parts, triangular stipules with 1 x 0.3 cm, composite bipinnates leaves have 6 -12 pairs of leaflets, with 6 cm of , and 1.4 cm , leaflets obovate with 0.8 x 0.4 cm , leaflets of the base larger than the leaflets of the apex of the pinnas, petiole with 1 x 0.2 cm , presence of trichomes with 1 mm of , smooth margin, apex of rounded leaflet, symmetrical, with penninerved veins, inflorescence raceme, flower absent, fruit legume with 0.3 x 0.2 inches long, arranged in the petiole with 0.3 cm, 3-6 articles. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 64 (HABIT).

15. *Aeschynomene histrix* Poir. Encycl., Suppl. 4 (1): 77-78, 1816.

Description: Herb, presents on average 45 cm, erect decumbent growth, triangular stipules present with 0.3 x 0.1 cm, it presents at the base of the petiole, striated,

composite leaves bipinnates with 10-18 pairs of leaflets, alternate phyllotaxy; petiole 4 x 0.4 cm, leaflets 0.7 x 0.2 cm, opposite, oblong, whole leaf margin, apex acuminate, with whitish trichomes; flower absent; dry fruit, lomentum legume, with about 3cm . presents from 4 -7 items dressed.

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 6, 7, 8 (HABIT).

16. *Aeschynomene paniculata* Willd. ex Vogel (Linnaea) 12: 95-96, 1838.

Description: Herb, with 60 cm , decumbent erect growth, grayish branches, presence of triangular stipules with 0.1 x 0.1 cm ; garment with few whitish trichomes; 0.6cm petiole; leaves approximately 6,5 x 3 cm composed of 12-25 pairs of leaflets, bipinnates, alternating phyllotaxy, absence of nectaries; oblong leaflet, 1.0 x 0.3 , whole margin, rounded leaf apex; median leaflets larger than the base and apex, cymose inflorescence with 0.3 cm , absent flower, fruit legume lomentum with 5 articles.

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO 55 (HABIT).

17. *Phaseolus vulgaris* L. Sp. Pl. 2: 723,1753.

Description: Herb stems climbing herb, prostrate erect growth, 20cm long, greenish branches, absent stipules, trifoliolate composite leaves, alternating, leaflets with sagittarius, 8 x 4.3 cm, petiole with 0.2 x 0.1 cm, leaves 8.2 cm, whole wavy margin, penninerved vein, acute leaf apex, symmetrical, reduced pulvinus, truncated rachis, absent fruit and flower absent. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 01 (HABIT).

18. *Macroptilium atropurpureum* (Sessé & Moc. ex DC.) Urb. Symb. Antill. 9 (4): 457, 1928.

Description: Herb with approximately 60 cm, Herbaceous stem, erect decumbent growth, green branches with 21,5 cm of, and 16 cm. triangular stipules of approximately 0.2 cm, and 0.1 cm, composite leaves, alternate, trifoliolate with 6 x 4 cm, leaflets oblong-lanceolate to sagittal of 4 x 1.8cm. wavy margin, rounded apex, penninerved vein, symmetrical, slightly pilose, lobed lateral leaflets sessile and main leaflet extended by rachis, absent flower, dry fruit legume type with 6 x 0.4 cm, indecipherable. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI

/ 17, G. S. GOMES; G. M. CONCEIÇÃO, 61, 62 (HABIT).

19. *Macroptilium lathyroides* (L.) Urb. Symb. Antill. 9 (4): 457, 1928.

Description: Herb, decumbent erect growth, approximately 30cm , greenish branches, tiny triangular stipules present with 0.5 x 0.2 cm , presence of nectary rounded in the petiole, composite leaves trifoliolate, phyllotaxy distal alternate, leaflet lanceolate to linear, with 4 x 2.6 cm , petiole 5 x 7.0 cm long leaf, whole leaf margin, acute leaf apex, symmetrical, leaf apex obtuse to codiform, presence of scattered trichomes, absent flower, dry fruit type legume long, approximately 5.6cm.

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 54 (HABIT).

20. *Galactia jussiaeana* Kunth. Mimos. 196-200, pl. 55, 1824.

Description: Herb, decumbent erect growth, 1m long, presence of triangular stipules with 0.4 cm, trifoliolate composite leaves, alternate phyllotaxy, oblong leaflets with trichomes, leaflet with 3x 1.7 cm , petiole 3.0 cm, leaf approximately 6,0 cm, whole leaf margin, emarginated leaf apex, penninerved vein, trichomes on leaflets and branches, hairiness, symmetrical leaflet, absent flower, fruit dry legume type with 6x 0.3 cm , terminal apex of falcate fruit. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Serra do Cajuí Village, 14 / II / 17, G. S. GOMES; G. M. CONCEIÇÃO, 18 (HABIT).

21. *Stylosanthes viscosa* (L.) Sw. Prodr. 108,1788.

Description: Herb, 30 cm, decumbent erect growth, greenish branches, with triangular stipules of 0.5 cm , at the base of the petiole, composite leaves trifoliolate, phyllotaxy distal alternate, leaflets elliptical, with 1.9 x 0.6 cm, petiole with 0.5 x 0.2 cm , leaf with approximately 2.5 cm, whole margin, acute leaf apex, penninerved vein, presence of glandular trichomes in all branches, homogeneous pilosity, symmetrical leaflets, cymose inflorescence with 4,5 cm, dichlamydeous, heterochlamydeous, gamosepalous with 0.4., gamopetalous with zygomorphic symmetry, papilionaceous yellow flowers with, striated standard marked with red coloration, Fruit absent. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 46 (HABIT).

IV. CONCLUSION

In this research, three new occurrences were obtained to the Maranhão with *Desmodium subsecundum* (Papilionoideae), *Aeschynomene viscidula* (Papilionoideae) and *Vigna lasiocarpa* (Papilionoideae), with *V. lasiocarpa* being a new ledger to the Northeast. This research is relevant for the Northeastern flora, through the increase of knowledge of the Leguminosae family characteristics and the expansion of the geographic distribution of the species in the region. proved to be very diverse in Cerrado Maranhense, making the work the largest survey in the family's geographical area for the State through a pioneering research for the area, building an important knowledge in the field of botanical study, thus offering taxonomic keys that will serve as recognition and identification of the species for the Cerrado of the state.

Producing taxonomic works on Leguminosae is of extreme importance, so it is possible to understand several characteristics which are still unknown. The morphological and taxonomic diversity of Leguminosae is expressed in its high number of taxa that is distributed in almost all regions of the world.

Leguminosae proved to be very diverse in Cerrado Maranhense, making the work the largest survey in the family's geographical area for the State through a pioneering research for the area, building an important knowledge in the field of botanical study, where the taxonomic keys produced will serve as recognition and identification of the species for the State Cerrado.

The importance of the research is also evidenced by providing information for the conservation and management of these new occurrences from taxonomic data. It can be mentioned that the species indexed as a new occurrence will contribute to the construction of the Brazilian Flora, through the REFLORA 2020 Project, which intends to index all Brazilian plant species until the year 2020, fortifying the data of Maranhão and the Northeast region, thus guaranteeing greater representation of Brazilian biodiversity.

REFERENCES

- [1] APG IV. (2016). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society. v.181, p. 1–20
- [2] Barneby, R. C. (1991). *Sensitiva ecensitae*: a description of the genus *Mimosa* Linnaeus (Mimosaceae) in the new world. Bronx: The New York Botanical Garden, p. 835.
- [3] Batalha, M. A. (2011) O cerrado não é um bioma. *Biota Neotropical*. v. 11, n. 1, p. 21-24.
- [4] Bentham, G. Leguminosae. In: Bentham, G.; Hooker, J. D. (1865) *Sistens dicotyledonum polypetalorum ordines XI: Leguminosae-Myrtaceaeas*. Genera Plantarum. London: Lovell Reeve e Co, v. 1, n. 2, p. 434-600.
- [5] Cronquist, A. (1981). An integrated system of classification of flowering plants. Columbia University Press, New York. p. 1262.
- [6] Domingos, A. H.; Carpelari JR, L. (2016). Plantas medicinais patas-de-vaca. Piracicaba: ESALQ - Divisão de Biblioteca, p. 32.
- [7] Fernandes, A. (1996). O taxon *Aeschynomene* no Brasil. Fortaleza, CE: Editora da UFC., 128 p.
- [8] Fidalgo, O.; Bononi, V. L. R. (1989). Técnicas de coleta, preservação e herborização do material botânico. Instituto de Botânica de São Paulo. p. 62.
- [9] Flora do Brasil. Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. Disponível em: <<http://floradobrasil.jbrj.gov.br/>>. Acesso em: 27/07/2015.
- [10] Graham, P.H.; Vance, C.P. (2003). Legumes: Importance and constraints to greater use. *Plant Physiol*. 131: 872–877.
- [11] Hutchinson, J. (1964). The genera of flowering plants. Oxford University Press, Oxford. v. 1. p. 516.
- [12] IBGE. Indicadores sociais municipais: uma análise dos resultados do universo do censo demográfico 2010. Rio de Janeiro. IBGE. p. 151, 2010. Disponível em:<http://www.ibge.gov.br/home/estatistica/populacao/censo2010/indicadores_sociais_municipais/indicadores_sociais_municipais.pdf>. Acesso em: 21/06/2017.
- [13] Isely, D. *Orbexilum*. (1990). In: *Vascular Flora Southeastern United States*. Chapel Hill: University of North Carolina Press. v. 2, p. 99–102.
- [14] Lewis, G. P. (1987). Legumes of Bahia. *Royal Botanic Gardens, Kew*. p. 369.
- [15] Lewis, G. P.; Schrire, B. D.; Mackinder, B. A.; Lock, J. M. (2005). *Legumes of the World*. Royal Botanic Gardens, Kew. p. 577.
- [16] Lima, L. C. P.; Queiroz, L. P.; Tozzi, A. M. G. A.; Lewis, G. P. A. (2014). Taxonomic Revision of *Desmodium* (Leguminosae, Papilionoideae) in Brazil. *Phytotaxa*. v. 169, p. 001–119.
- [17] Lima, L. C. P.; Oliveira, M. L. A. A. *Aeschynomene*. In: R. C. Forzza et al. Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. 2010. Disponível em: <http://floradobrasil.jbrj.gov.br/2010/FB022778> Acesso: em 20/07/2017
- [18] LPWG. Legume Phylogeny Working Group. (2017) A new subfamily classification of the Leguminosae based on a taxonomically comprehensive phylogeny. *Taxon*. v. 66, n.1, p. 44–77. Doi: <https://doi.org/10.12705/661.3>
- [19] _____. (2013) Legume Phylogeny Working Group. Legume phylogeny and classification in the 21st century: Progress, prospects and lessons for other species-rich clades. *Taxon*. v. 62, p. 217–248. Doi: <https://doi.org/10.5167/uzh-78167>
- [20] Maranhão. (2011). Plano de Ação Para Prevenção e Controle do Desmatamento e das Queimadas no Estado do

- Maranhão. Governo do Estado do Maranhão. Secretaria de Estado do Meio Ambiente e Recursos Naturais. p. 110.
- [21] Maréchal, R.; Mascherpa, J. M.; Stainier, F. (1978). Etude taxonomique d'un groupe complexe d'espèces des genres *Phaseolus* et *Vigna* Papilionaceae sur la base de données morphologiques et polliniques, traitées par l'analyse informatique. *Boissiera*. v. 28, p. 1-273.
- [22] Ormond, J. G. P. (2006). Glossário de termos usados em atividades agropecuárias, florestais e ciências ambientais. Rio de Janeiro. BNDS, p. 316.
- [23] Queiroz, L. P. (2009). Leguminosas da Caatinga. Universidade Estadual de Feira de Santana. Royal Botanic Gardens; Associação Plantas do Nordeste, p. 467.
- [24] Ribeiro, J. F. (1998). Cerrado: Matas de galeria. Embrapa-CPAC, Planaltina, p.164.
- [25] Silva, R. R., Fortuna-Perez, A. P.; Tozzi, A. M. G. A. (2007). Novas ocorrências de Leguminosae para o Mato Grosso do Sul, Brasil. *Rodriguésia*. v. 58, p. 249-254.
- [26] Simon, M.F.; Grether, R.; Queiroz, L.P.; Särkinen, T.E., Dutra, V.F. & Hughes, C.E. (2011). The evolutionary history of *Mimosa* (Leguminosae): toward a phylogeny of the sensitive plants. *American Journal of Botany* 98: 1201-1221.
- [27] Sprent, J.I., Ardley, J.K., James, E.K. (2013). From North to South: A latitudinal look at legume nodulation processes. *S. Afr. J. Bot.* 89: 31–41.
- [28] Strassburg, B. B. N.; Brooks, T.; Feltran-Barbieri, R.; Iribarrem, A.; Crouzeilles, R.; Loyola, R.; Latawiec, A. E.; Oliveira-Filho, F. J. B.; Scaramuzza, C. A. M.; Scarano, F. R.; Soares-Filho, B.; Balmford, A. (2017). Moment of truth for the Cerrado hotspot. *Nature Ecology & Evolution*. v. 1, n. 0099, p. 1-3.
- [29] Tropicos. (2018). Tropicos.org. Jardim Botânico de Missouri. 10 de fevereiro de 2018 disponible in <<http://www.tropicos.org>>
- [30] Yahara, T.; et al. (2013). Global legume diversity assessment: Concepts, key indicators, and strategies. *Taxon*. v. 62, p. 249–266. Perfect, T. J., & Schwartz, B. L. (Eds.) (2002). *Applied metacognition* Retrieved from <http://www.questia.com/read/107598848>

Organizational Learning - The main factors that facilitate learning and the barriers from the perspective of managers

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Abstract—This study seeks to identify and analyze the aspects that favor and those that hamper learning in the organization according to the perception of managers Coamo Cooperativa Agroindustrial unit of Paranaguá PR, analyzing how the learning process in an organization can be favored and what barriers can be found. Having as justification that through the understanding of the presented problem, it is possible to constitute a diagnosis of the organizational practices. With the necessary practices in the process of change and development of the organization bringing the proposal of the learning in order to improve the capacity of action of the individuals involved and of the organization as one all. It begins by contextualizing the objective of this study, presenting a review of the referential with the survey of the most relevant and pertinent aspects to the theme. Following, a description of the methodology adopted in this research carried out in the exploratory qualitative research modality, which contemplates a case study. The research was carried out at the Coamo Agroindustrial Cooperativa Unidade de Paranaguá in Paraná, with questionnaires applied to the members of the company. Because it is a study of a specific case, the research delimits the analysis in the experience of a working group within an organization, however it was possible to have the vision about learning, as it happens, which can facilitate or impair learning in an organization.

Keywords—Factors for learning, learning process, organizational learning, types of learning.

I. INTRODUCTION

The central idea that led to the execution of this work was the interest in the growing process of learning regarding the organization, the ways in which they can lead to a better use of collective and individual knowledge of the team, with the purpose of generating competitive

advantages for the organization. Thus, the desire for analysis of the learning and knowledge generation aspects was stimulated.

One of the purposes of this work was to analyze organizational learning, understanding how organizational learning happens, raising the main organizational learning practices and identifying obstacles to organizational learning. From the understanding of the learning process within the organization, through data surveys one can then theorize about it.

The performance of organizations is directly aimed at those who make it up; its employees, then the individual and knowledge are seen as strategic means for the creation and dissemination of new values and resources that corroborate in the improvement of processes. In face of daily changes the internal and external environment in organizations, in this context, identifying the observation that intangible assets are becoming key components in organizations. Thus making it essential to adapt to the environment in order to remain competitive, promoting in some way learning through acquisition of information or knowledge that its members consider useful for the quality of the organizational performance. It is the exposed of which the main factors that somehow facilitate the organizational learning and factors or barriers for the learning in the managers view.

The theme of learning within organizations has emerged with great relevance both in the question of theoretical and in managerial practice. It consists of the capacity that organizations develop in a way that acquires knowledge from experiences, which in turn will bring about changes in their functioning based on such knowledge, thus increasing its capacity to generate and apprehend knowledge, a factor that has been the main competitive differential of organizations in the current context.

Vasconcelos and Mascarenhas (2007) in this same line of thought indicate that learning presupposes behavior change resulting from a continuous and growing acquisition of knowledge about oneself and about the environment. This given, the development of learning is seen as the acquisition of knowledge that causes that in addition to the individual who is being shaped or who has a modification of the vision of what he knows, begins to observe in another way the environment in which it is inserted, acting in a different way than it was before learning.

In the question of the competitive differential, Prahalad and Hamel (1995) corroborate in this sense that a company becomes more competitive the moment they turn to the attention for essential competences. It is represented as an expanding set of knowledge, the sum of the learning from all skill sets on a personal level as well as from the organizational unit. In short, the learning process can be facilitated when the environment is conducive to development in the organization, but can also be impaired when there are barriers or barriers to learning.

In this sense, the analysis of learning processes in organizational contexts has been an important way to understand the dynamics of organizations. The changes resulting from social systems have repercussions on the configuration of new organizational formats and the adoption of managerial models. These managerial models, in turn, require employees and managers willing to learn. Since it is, the ability to learn that allows the development of skills that enable the organization to identify process and retain new information to increase knowledge and improve the process of making competitive capacity (Bastos, Gondim, & Loiola, 2004).

Durand (apud Brandão, 1999) suggests a concept of competency based on three dimensions - knowledge, skills and attitudes - associating cognitive, technical, social and affective aspects related to work. Knowledge corresponds to a series of information assimilated and structured by the individual, which allows him to "understand the world". Skill corresponds to the ability to apply and make use of the knowledge gained in pursuit of a definite purpose. The attitude refers to the social and affective aspects related to the work, which explain the behavior normally experienced by the human being in his work environment. The three dimensions proposed, according to Durand (apud Brandão, 1999) occur simultaneously, since an individual does not perform a task that requires the application of a certain skill, without first knowing the fundamentals of it. It is necessary for organizations to incorporate this learning cycle: Where they first acquire skills, they come to know their reality and then the necessary knowledge is generated, in this

way the attitudes will be: Inhibited, stimulated or developed in people.

In Argyris and Shon (1976) propose the existence of two learning models, called single loop and double loop, based on the theory that all human action was based on theories of action. According to the authors, single-loop or simple cycle learning is an instrumental learning involving the detection and resolution of problems according to the rules established by the organization (its theory of action). Individuals claim to follow one theory, and in fact, unconsciously practice another. In other words, a resistance arises to critically observe situations, which causes inhibition to question existing rules and procedures and the development of new solutions, to let the values of a theory of action remain unchanged, that is, it detects and corrects the error, but does not change the current model.

Dual-cycle learning would involve overcoming this defensive posture, questioning what is established in the organization, and, through learning the situation, promoting the changes necessary to achieve solutions. This is to question what is learned by doing a revision of principles, in turn, occurs when, in addition to the detection and correction of error, changes in norms, policies and objectives occur. That is, when, in addition to correction of error, learning also covers the development of avoid it, it gives the learning double-loop or dooble-loop with reference to two feedback loops. (ARGYRIS; SCHÖN, 1996).

Contextualizing Senge (1990) in his studies contributes by referring to the simple circuit as generative learning that emphasizes continuous experimentation and feedback, which involves the analysis of how organizations define and solve problems using the disciplines of personal domain, mental models, shared vision, group learning, and systemic thinking. In contrast, dual circuit is considered as adaptive learning by focusing on problem solving in the present, without properly examining current learning behaviors.

Other authors such as DiBella and Nevis (1999) also present the organizational learning cycle that portrays a series of three processes: generation or acquisition of knowledge, dissemination of knowledge and use of knowledge. The occurrence of learning requires the realization of all processes of the cycle, and unless knowledge is disseminated, it will remain as private property and not as property of the organization.

Thus, the Ten Facilitating Factors are conceptualized, they reflect the influence they exert on each segment of the organizational learning cycle: Imperative Research: People seek information about conditions and procedures outside their own unit; seek to know the external environment. Performance Diffusion:

Generalized perception that there is a difference between actual and desired performance. Concern with Measurement: Considerable efforts are spent on defining and measuring basic factors. The discussion of measurement criteria is considered a learning activity. Organizational Curiosity: The curiosity about conditions and practices and the interest for creative ideas and new technologies, propitiate the experimentation. Opening Climate: Members of the organization communicate openly; problems, mistakes and lessons are freely shared, never hidden. Continuing Education: There is a constant commitment of the organization to provide a high quality resource for learning. Operational Variety: Members value the variety of methods, procedures, and competencies; appreciate diversity. Multiple Defenders: Employees at all organizational levels are encouraged to develop new ideas and working methods. Existence of multiple advocates or leaders. Leadership Involvement: Leadership is involved, personally and actively, in learning initiatives and ensures the maintenance of an environment conducive to its occurrence. Systemic perspective: Recognition of the interdependence of the various organizational units and groups; awareness of the need to pass time between actions and obtain their results.

In the model of learning proposed by Senge (1990) shows that the desire to learn is creative and productive, however, people will only show better results in their activities and in the processes of the organization when they have knowledge of their contribution in the process of organizational change. Senge proposes the development of five fundamental disciplines: personal domain, mental models, shared vision, team learning and systemic thinking. It is of fundamental importance that the five disciplines work together. (Senge, 1990, p. 21).

According to studies of several authors in the area of organizational learning, there are means that favor and means that make learning difficult in organizations, synthesized among the contributions in the facilitator aspect. The contributions of the authors DiBella and Nevis (1999) emphasize that the facilitators of organizational learning have normative characteristics, because the stronger the presence of them in an organizational unit, the greater the probability for learning to occur. The facilitating factors for learning are the political practices and conditions that catalyze the occurrence of learning. That is, the sources of information, the sharing of visions and experiences, the acceptance of surprises and difficulties, the revision of preconceptions, the feedback new ideas and opinions, the learning environment and psychological safety, providing the reasons and incentives that promote this learning in the organization. In this same vision Garvin, 2000, defines the facilitating factors of learning as: Sources of

information, sharing visions and knowledge, acceptance of surprises, review of prejudices, timely feedback, new ideas and opinions, learning environment, psychological security.

Tied to facilitators or the process, are the basic parameters to describe or characterize as organizational learning as the authors DiBella and Nevis (1999) about how learning occurs through knowledge sources where development occurs internally or externally. It is developed by the content focus in which process the emphasis given to the knowledge about what it represents, the products or the services compared to the emphasis given to the knowledge about these products or services are developed and made available to the market. The reserve of knowledge, i.e. knowledge that is of particular domain compared to knowledge that is in the public domain. The mode of dissemination, as knowledge is shared, whether through formal or rigid methods compared to the knowledge that is shared informally in casual contacts or which is the result of behavioral modeling learning scope. This model defines what the preference for knowledge related to the improvement of capabilities, existing products or services compared to the preference for knowledge related to the development of new capabilities, products or services. Focus value chain in this case the emphasis given to investments in learning related to engineering or production activities (functions of type design and execute) versus sales or service (depending on the type markets and delivered). Finally the focus on learning: the development of knowledge pertaining to individual performance compared to the development of knowledge pertaining to group performance.

At all stages of learning there are several deficiencies that can occur and can disrupt the process, reducing its efficiency. Morgan (1996) reports that the organizational learning process often comes up against bureaucratic approaches in organizations that impose fragmented structures of thought on employees, not encouraging people to think for themselves. Through established organizational goals, goals, structures and roles, the company creates defined patterns of attention and responsibility by fragmenting interest in a knowledge of what the organization is doing.

Some of these barriers are created by stress, pressure and high expectations, causing attention and focus to be reduced, generating learning problems where, according to Garvin's studies, 2000, these barriers are the biased information that are caused by blind spots, bad judgments that restrict the amount of information processed, leading to incomplete and incorrect assumptions. In addition, the fault interpretation that is very common for the complexity of the interpretative

judgment that can be polluted by particularities of the individuals, generating distorted information; the inaction that can be translated by the lack of capacity to act in relation to the new information captured. The changes must be clear and understood, understanding the need for these new actions;

Through the different theoretical contributions, it is observed that, in learning organizations, people are not trained to simply perform their functions, but rather to perform a work of excellence that adds value to feeling satisfaction.

II. MATERIALS AND METHODS

This study is a case study of a quantitative and descriptive exploratory nature. For GIL (1999) the case study is characterized as a research of high degree of depth and of exhaustion that allows the deepening of one or few objects in a detailed way.

According to Mattar (2007), the descriptive modality is used with the objective of: "Describe the characteristics of groups, estimate the proportion of elements in a specific population that have certain characteristics of a given problem and describe behavior and discover or verify the existence of relation between variables".

The methodology of this exploratory study has a quantitative approach through the application of research, in which this approach was chosen in the quest for the accuracy of the results obtained, thus providing a greater security in the analysis to be performed.

In the identification of the data collection were used primary sources, where as a technique of data collection was used the questionnaire, according to Cervo, Bervian and Silva (2006), makes it possible to accurately measure what is desired. According to Marconi and Lakatos (2007), the questionnaire is an instrument of data collection, consisting of an orderly sequence of questions, for better data collection should be answered in writing and without the presence of the interviewers. With the option of non-interviewees placing their identification so that the questionnaire has an effect of proximity to reality, will allow to cover a larger number of interviews.

The secondary data were extracted from the existing literature on the subject and incorporated into the field research. It contacts an already existing questionnaire composed of closed questions, extracted from the studies of Alcântara (2014).

In the analysis of the collected data the likert scale was used with answers of 1 to 5, where 1 - I totally agree; 2 - I agree; 3 - Neutral; 4 - I disagree; 5 - I totally disagree. According to Malhotra (2001), we use a measurement scale with five categories of responses, ranging from "Strongly Disagree" to "Strongly Agree",

which requires respondents to indicate a degree of agreement or disagreement with each of the variables related to stimulus objects.

The questions were grouped in facilitating factors, being: Imperative Research and sources of information. Performance gap and sources of information. Concern with measurement and feedback. Organizational curiosity and acceptance of surprises. Opening climate and learning environment. Continuing education and learning environment. Operational variety and sharing visions and knowledge. Multiple advocates and psychological security. Involvement of leaderships, revisiting prejudices, new ideas, and opinions. Systemic perspective and sharing of visions and knowledge.

After tabulation and calculations via Excel program, graphs were produced to illustrate the samples demonstrating the degrees of agreement by facilitator factors and stages of the knowledge cycle. In sequence, the graphs were analyzed according to the Likert Scale Values Interpretation table.

2.1. DATA COLLECTION

The research was carried out by means of a virtual questionnaire, where a link of a web form (Google forms) was sent to the leaders of the study organization, which was answered between January and February 2019.

The research universe comprised 16 responses obtained by the interviewees. This questionnaire was the guideline of the research where it was elaborated in order to understand the main factors that somehow facilitate organizational learning and factors or barriers to learning in the managers' view.

III. INCOME STATEMENT

At the request of the interviewees their names were preserved. The profile of the interviewees in which the questionnaire was applied, who in turn are managers, among which are department heads, operational managers, operational assistants, maintenance and security officers. As for the gender account has 15 males and 01 of the sex female, about 80% work in the organization for more than ten years, being the interviewee with a shorter time of two years, in relation to their training 90% have higher education and relevant technical knowledge in their respective areas.

3.1 FIGURES AND TABLES

Table.1: Imperative research and sources of information

Description	Standard deviation
1. Do you care to seek information that contributes to the improvement of your processes based on the best practices adopted by your competitors / partners?	4,438
2. Do you seek information that contributes to the understanding of your environment with your peers (meetings, meetings, events)?	4,381
3. Do you use the information of the results obtained by your organization comparative to other organizations and their positioning towards suppliers, customers?	3,701

Based on the obtained answers, the standard deviation of this factor had as its highest value the question 01 of 4,438 where they are represented by 43.8% of the respondents. The respondents said they agree and 56.3% agree fully, and the lowest value is question 03 with 3,701, represented by 25% of the respondents who fully agree, 56.3% agree and 18.8% are neutral.

Table. 2: Performance gap and sources of information

Description	Standard deviation
4. Do you seek to achieve the goals specified by the organization in relation to your processes?	4,438
5. Do you care to question your work regardless of the goals you set?	3,962

In the item Performance gap and information sources, the highest standard deviation was 4,438 where 56.3% of respondents fully agree and 43.8% agree and represent 3,962 of standard deviation, 50% of respondents fully agree, 43, 8% agree and 6.3% are neutral.

Table.3:Preoccupation with measurement and feedback

Description	Standard deviation
6. Are there questions about how things are done?	4,086
7. Do you evaluate the results obtained from a new knowledge added to your processes?	4,604

Concerning measurement and feedback, these are important factors in the generation and maintenance of a learning process. The variable of question 07 presented the

highest value of standard deviation 4,604 in which 62.5% agreed and 37.5% agreed fully, already with 37.5% agreeing fully, 56.3% agreeing and 6.3 neutral ones the standard deviation value of 4.086.

Table.4: Organizational curiosity and acceptance of surprises

Description	Standard deviation
8. Do you allow yourself to try new ways of acting / working?	4,381
9. Do you use contingencies to create new work routines?	4,438

In the factor Organizational curiosity and acceptance of surprises with the value of 4,438 represents the highest standard deviation of this item in which 56.3% fully agree and another 43.8% already agree with the lowest value 4.381 represented by 50% of respondents who fully agree and another 50% who agree.

Table 5: Organizational curiosity and acceptance of surprises

Description	Standard deviation
10. You have a habit of sharing best practices with other coordinators of other organizations	2,774
11. Coordinators from other organizations are in the habit of sharing their best practices with you.	2,588

In this item, the standard deviation with the highest value presented with 2,774 was in question 10, where 37.5% fully agree, 37.5 agree 18.8% if they say neutral and another 6.3 disagree. Representing 2,588 of standard deviation in question 11, 25% fully agree, 31.3% agree on 37.5 neutral and 6.3 are discordant.

Table 6: Continuing education and learning environment

Description	Standard deviation
12. You seek continuous improvement to improve your processes.	4,381
13. You seek unstructured improvement on an ongoing basis to improve your processes.	2,949
14. You are free to pursue this improvement in your work schedule.	3,834

In the continuing education factor and learning environment were divided into 50% those who fully agree and 50% who agree, representing the highest value of

standard deviation in the answers in question 12, with the standard deviation value 2,949, 18.8% fully agree, 50% agree, 18.8% neutral and 12.5% disagree..

Table 7: Operational variety and sharing visions and knowledge

Description	Standard deviation
15. You have the flexibility to propose alternative solutions to the problems you face.	4,868
16. Other coordinators have the flexibility to propose alternative solutions to the problems they face.	4,147
17 There is this flexibility of proposing alternative solutions between sectors / departments de soluções alternativas entre setores/departamentos	4,658

Regarding the operational variety and sharing of views and knowledge, the highest value of standard deviation of the answers obtained was 4,868 in question 15, where 31.3% fully agree and 68.8% agree on question 16, the standard deviation was 4,147 had as answers 25% fully agree, 62.5% agree and 12.5% are neutral.

Table 8: Multiple Defenders and Psychological Safety

Description	Standard deviation
18. There are favorable conditions for the implementation of new processes based on suggestions.	5,215

The Multiple Defensor and Psychological Safety factor had the standard deviation in the responses of 5,215 where 25% fully agree and 75% agree.

Table 9: Involving leaders and reviewing prejudices, new ideas and opinions

Description	Standard deviation
19. The leaders of your organization institution stimulate the learning environment.	4,438

Regarding the involvement of leaders and revising precepts and new ideas and opinions with 4,438 in the standard deviation, 43.8% fully agree and 56.3% agree.

Table 10: Systemic Perspective and Sharing of Visions and Knowledge

Description	Standard deviation
20. You are able to identify an external factor as an opportunity or threat to your Institution.	4,604
21. You are able to identify an internal factor as an opportunity or threat to your Institution.	4,086

In the Systemic Perspective and sharing of views and knowledge the standard deviation of the answers obtained representing 4,604 with 37.5% who fully agree and 62.5% agree, and 4,086 of standard deviation 56.3% agree, 37.5% fully agree and 6.3% neutral.

IV. DISCUSSION

Observing the results demonstrated in the previous session in which they are presented through the factors influencing or hindering learning. In the item of tab.1 it was tried to evaluate the factor Investigation imperative and sources of information in which given its importance, according to Garvin (2000) the learning can only occur in organizations that have a great source of information. According to Costa (2003), information is conceived as raw material to generate knowledge. It can be observed that there is interest in the search for information aiming to contribute to the improvement of learning, but it is usual to compare the results with the external environment.

As described in tab.2 the learning potential is commensurate with the openness offered by the organization so that stakeholders can identify and discuss the effects of performance gaps by questioning their independent performance of goals demonstrating engagement with results. Performance Perception represents collective awareness of the differences between actual, concrete and objective performance and desired or expected performance. As represented here is the involvement by the majority interviewed in the concern with the performance gap in relation to the concern in questioning what is accomplished with a personal charge for the results to be achieved.

In tab.3 the item concern about measurement and feedback, it is believed that through joint participation, the practice of dialogue works as an incentive to the development of new skills, contributing to the decision-making and implementation of more effective actions. The concern with this measurement indicates a certain degree of commitment to learning, the greater this concern, the more adequate will be learning in the organization (DIBELLA, NEVIS, 1999).

Organizations whose individuals are predisposed to accept unexpected events and surprises, occurrences out of sight during the day, allow the creation of an environment for organizational learning, Gavin (2000). According to the results shown in tab. 4, the organizational structure is very dynamic and the flexibility of the individuals that make up the organization is fundamental. It is important that they are adaptable to possible changes and rapid transformations by analyzing the answers it is possible to observe that the interviewees deal with unforeseen changes into new forms of action.

In relation to the opening Climate and learning environment this factor is related according to Dibella; Nevis, (1999) with the freedom of communication that individuals possess among other sectors, within their own sector and among other organizations. Through the result described in tab.5 it is possible to understand that the respondents perceive the existence of this factor, but disagree with the existence of this factor in the relations with distinct organizations.

According to Garvin (2000), "learning organizations are organizations that are capable of creating, acquiring and transferring knowledge and modifying their behaviors to reflect these new insights and insights" DiBella and Nevis (1999), organizations need to create an enabling environment education continues for both the subjects of immediate and technical use as well as for the disciplines coming from individual initiative. One can see the answers obtained in items 12 and 14 of tab.6 that the organization provides an environment that facilitates learning through continuing education and the employees have stimulated the search for improvement.

In the item Operating variety and share views and knowledge in the tab.7, it is exposed that there is possibility and effective participation of the groups involved in the decisions and are stimulated the participation and in proposing alternatives to the problems. Organizations that support diversity and variations in the strategies, policies, processes and skills of their individuals provide a more efficient learning environment, Garvin (2000).

With regard to the multiple advocacy factor and psychological security, this factor tries to evaluate the effect of individuals able to defend new ideas and processes throughout the organization, as explained by DiBella and Nevis (1999). Through the result obtained according to tab.8 it is possible to state that everyone is encouraged to develop new ideas and working methods.

It is also possible to observe through the results of tab. 9 that the leaderships are actively involved in the learning initiatives and thus ensuring an environment conducive to their occurrence. If the organization's goal is

to foster learning, it will be up to leaders, in addition to involvement, to ensure that the learning environment is maintained (DIBELLA; NEVIS, 1999);

Finally, through the results of tab.10 it is possible to describe that respondents aim to build the vision of business owner by committing themselves to the results they are delivering to the organization having the ability to identify their own organizational boundaries before looking for external motives and reasons. It concerns the ability to observe short-term results and to understand how they can affect the organization in the long term or determine the outcome of other parts of the organization (DIBELLA and NEVIS, 1999).

V. FINAL CONSIDERATIONS

The objective of this research was to analyze which are the main factors that facilitate in some way the organizational learning and factors or barriers to learning in the view of the managers. In order to reach this goal, a review of the theory about organizational learning was carried out, factors that bring benefits and factors that make learning difficult. It was also sought to identify the main components of knowledge practices in which factors related to communication were raised organizational, knowledge strategies, stimulus to learning, organizational climate and feedback, capacity measurement and access to information.

With the results obtained from the research, it is possible to raise the existence of facilitating factors and impediments of organizational learning in the theoretical context. Compared to practice, the members of the organization interviewed who in turn are managers, and most male who act at a considerable time in the organization. The great majority has been working for more than ten years in the organization, 90% of them have higher education and relevant technical knowledge in their respective areas, and can be considered as learning enablers and disseminators of knowledge. It is possible to affirm that the learning in this specific study is influenced by the organizational set, that is, the organizational culture stimulates the learning, to what is impregnated, what is exposed in those that compose the organization is responsible for the stimulus to the learning. The set of personal and organizational aspects that arise from the work environment available, want to learn and teach, the relationship between the agents involved, access to information and openness in the sharing of opinions and knowledge translate the openness to learning. The counterpart can be drawn from the bibliography already produced that inhibiting factors such as fear of exposure, culture of obedience, excess of norms and procedures, intolerance to error, individualism and

pressures are responsible for the regression in the learning.

To perform the verification of the data, it was found that the results indicate that respondents seek for information that contributed to the improvement of processes. However, it is not common to use the information from the results obtained by your comparative organization the other organizations, as well as for the involvement of respondents in concern with the performance lag where one has the concern in question what is accomplished and the possible outcomes to be achieved. It also determines the degree of commitment to learning, where the higher this concern, more appropriate learning in the Organization, can be stated also that in this organization respondents allow themselves to experience in new forms of action in which use of consequential to create or improve routines. The organization's ability to innovate and learn is linked to the styles and values adopted by its members, how each individual retains information is based on their own experiences, observations, and values (ARGYRIS & SCHON, 1996).

Regarding the Climate of openness and learning environment, this factor is explicit in the organization that contributes with sharing of visions and knowledge as well as suggestions that will collaborate through improvements, where it is also possible to affirm that it provides an environment that facilitates learning through education and the employees have a stimulus in the search for improvement.

The contribution of this study is to confront theory and practice in the confirmation of organizational learning, its benefits when applied correctly adding value to the company by developing personal skills that imply learning in the organization. The learning organization provides conditions for individuals to learn and retain knowledge, promoting organizational change so that it can act in the environment in which it operates effectively.

In this way, it allows to say that the proposed objectives were reached in the analysis of the organizational learning, being possible to understand how organizational learning happens, the main practices of organizational learning and the identification of the obstacles to organizational learning through the literature, responding to the general objective. The main factors that somehow facilitate organizational learning and factors or barriers to learning in the view of managers with the survey of the data through questionnaire with closed questions applied with the members of the organization in turn managers were raised and identified here.

REFERENCES

- [1] ALCANTARA, M.M. F. Fatores facilitadores da aprendizagem organizacional para a criação de significado em instituições de ensino superior privada de Curitiba e região metropolitana. Dissertação. (Mestrado em Gestão e Tecnologia da Informação do Setor de Ciências Sociais Aplicadas) da Universidade Federal do Paraná. 2014.
- [2] ARGYRIS, C.; SCHÖN, D. A. *Organizational learning II: theory, method, and practice*. New York: Addison-Wesley, 1996.
- [3] ARGYRIS, C.; SCHÖN, D. A. Organizational Learning: a theory of action perspective. p. 345- 348, 1997.
- [4] BASTOS, A. V. B., GONDIM, S. M. G., & LOIOLA, E. (2004). Aprendizagem organizacional versus organizações que aprendem: características e desafios que cercam essas duas abordagens de pesquisa. *R.Adm.*, São Paulo, v. 39, n. 3, p. 220- 230, jul./ago./set.
- [5] BITENCOURT, C.C. A. Gestão de Competências Gerenciais: A contribuição da aprendizagem organizacional. 2001 Tese (Doutorado em Administração) – Programa Pós-Graduação em Administração, Universidade Federal do Rio Grande do Sul, Porto Alegre, 2001.
- [6] BRANDÃO, Hugo P. (1999) Gestão baseada nas competências: um estudo sobre competências profissionais na indústria bancária. Dissertação (Mestrado) – Brasília - Universidade de Brasília, 158 p.
- [7] CALDEIRA, A.; GODOY, A. S. Barreiras e incentivos à aprendizagem. *São Paulo - SP, Brasil, v. 18, n. 4, p. 513-530, out./dez. 2011. REGE*.
- [8] CERVO, BERVIAN e SILVA, Metodologia científica 6ª edição. São Paulo: Editora Pearson Education do Brasil, 2006.
- [9] COSTA, Marília Maria Roslindo Damiani. Procedimentos para aplicação de mapas semânticos como estratégia para criação do conhecimento organizacional. 2003. 195 f. Tese (Doutorado em Engenharia de Produção), Universidade Federal de Santa Catarina, 2003.
- [10] DIBELLA, Antony J.; NEVIS, Edwin C. Como as organizações aprendem. São Paulo: Educator, 1999.
- [11] FERRAZ, A. P. C. M.; BELHOT, R. V. Taxonomia de Bloom: revisão teórica e apresentação das adequações do instrumento para definição de objetivos instrucionais. *Gestão&Produção, São Carlos, v. 17, n. 2, p. 421-431, 2010*.
- [12] GARVIN, David A. Learning in action: a guide to putting the learning organization to work. Harvard Business School Press: Boston, Massachusetts, 2000.
- [13] GARVIN, David A. Aprendizagem em Ação: um guia para transformar sua empresa em uma learning organization. Rio de Janeiro: Qualitymark, 2002.
- [14] GIL, Antonio Carlos. Métodos e técnicas de pesquisa social. 5 ed. São Paulo: Atlas, 1999.
- [15] LAKATOS, MARCONI. Técnicas de Pesquisa. 6 ed. São Paulo: Atlas, 2007.
- [16] MALHOTRA, N. Pesquisa de marketing: uma orientação aplicada. 3. ed. Porto Alegre: Bookman, 2001.
- [17] MATTAR, F.N. Pesquisa de Marketing. 3. ed. São Paulo: Atlas, 2007.
- [18] MOREIRA, M. A.. Aprendizagem significativa. Brasília: Editora Universidade de Brasília, 1999.

- [19] MORGAN, Gareth. *Imagens da organização*. São Paulo: Atlas, 1996.
- [20] NEVES, José Luis. *Pesquisa Qualitativa: Características, usos e possibilidades*. Cadernos de pesquisas em Administração. São Paulo, V.1 n3,2º Sem, 1996.
- [21] PRAHALAD, C.K, e G. HAMEL. *Competindo pelo futuro*. Rio de Janeiro: Campus, 1995.
- [22] RIGANO, D.; EDWARDS, J. Incorporating Reflection into Work practice. *Management Learning*, v.29, n. 4, p 431-446, 1998.
- [23] SENGE, Peter M. *A quinta disciplina*. São Paulo: Editora Best Seller, 1990.
- [24] SENGE, P. *et al.* *A quinta disciplina*. Caderno de campo. Trad. de Antônio Romero M. da Silva. Rio de Janeiro: Qualitymark, 1997.
- [25] SENGE, P.M. *A quinta disciplina: arte e prática da organização de aprendizagem: uma nova e revolucionária concepção de liderança e gerenciamento empresarial*. 23 ed. São Paulo: Best Seller, 2008.
- [26] SHAW, R. B; PERKINS, D.N. *Ensinar às organizações a aprender: O poder dos fracassos produtivos*. In: NADLER, David. *Arquitetura Organizacional: A chave para a mudança empresarial*. Rio de Janeiro: Campus, 1993.
- [27] VASCONCELOS, Isabella F.G de e MASCARENHAS, André O. *Organizações em aprendizagem*. Coleção debates em Administrações. São Paulo: Thomson Learning, 2007.

PEC-G: An Analysis of the Student Program-Graduate Agreement at the state university of Londrina - Brazil - in the Perspective of Students

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Abstract— *The Student-Graduation Agreement Program (PEC-G) is one of the instruments of educational cooperation that the Brazilian government offers to other developing countries in Asia, Africa and Latin America. The Ministry of Foreign Affairs (MRE) and the Ministry of Education (MEC) are mainly responsible for the overall coordination of the Program, while the Higher Education Institutions (HEIs) are responsible for the reception and training of students. In this sense, this article has as general objective to understand the Program of Students-Agreement of Graduation (PEC-G) at the State University of Londrina (UEL) from the perspective of the main social actors involved: the foreign students. Due to lack of space in this article, the position of the managers of the program in the UEL and in the MEC was left out. As for the research methodology, the Case Study and the Bibliographical Study were used, with a qualitative approach, the instruments of data collection were questionnaires and interviews. Among the conclusions of the study, it is possible to emphasize the students' deficiency in learning the Portuguese language before arriving in Brazil; the difficulty of living and the lack of resources to support themselves in Brazil; the need for investments by UEL in socialization actions of new students who enter each year at the University.*

Keywords— *Public policies; Social actors; Students.*

I. INTRODUCTION

The Undergraduate Student-Covenant Program (PEC-G) is a vacancy in Higher Education Institutions (HES) for foreign students whose objective is to attend undergraduate courses in order to become professionally qualified. The PEC-G represents one of the oldest international cooperation's in Brazil, which, according to Duarte (2016), in 1964, received its current denomination through the report of the Ministry of Foreign Relations - MRE, directing its own actions to the IES, without the participation of the Ministry of Education - MEC. In 1974, the MEC and the MRE signed the second protocol seeking its greater efficiency.

Currently, the Program is governed by Decree 7.948, dated March 12, 2013, repealing Decree 55.613, of January 20, 1965, whose purpose was to regulate and adapt the PEC-G. According to Duarte (2016), this was the first significant modification of the Program since its inception, being extremely important for monitoring Brazil's foreign relations.

The objective of the program is to strengthen

relations between governments, which need to pay for maintenance, accommodation, transport and food for students who come to Brazil to study. The benefits provided to Brazil in terms of foreign policy are to contribute to the development of the countries agreed by the qualification of students, and for the institutions the benefit is the opportunity for cultural and social exchange between foreign students and Brazilians.

It is the responsibility of the HES to host and train these students, thus requiring a continuous evaluation of the evolution of the Program and the valuation of PEC-G students, paying them in the academic environment and in research, teaching and research activities. extension.

In order for the students to achieve a good income, a policy built with the social participation of the actors involved is necessary.

For Höfling (2001), it is fundamental, in the implementation of the Public Policy, an evaluation in its implementation, and not only in the evaluation of the results created by it. With regard to Educational Policies,

which contextualize the object of study of this work, the G-PEC, it is worth observing what determines the legislation, the determination of education as a right of all, provided for in articles 6 and 205 of the Constitution of the Federative Republic of Brazil of 1988.

Souza (2006) states that Public Policies can be understood as a set of governmental decisions, plans, goals and actions, together with the state, federal and municipal spheres, aimed at solving problems or public interests, whose actions must reach the well-being of society.

For the foregoing, this article aims to answer the following question: what evaluation do foreign students conceive of the Undergraduate Students-Agreement Program (PEC-G) held at the State University of Londrina?

The performance of the university is of fundamental importance in the context of exchange and cooperation, and the strengthening of the development processes of the agreed countries, as well as the organization of the necessary procedures to offer experiences and experiences of reception and educational quality to the students. In this context, from the studies and results presented in the master's thesis "The undergraduate students-agreement program (PEC-G in the state university of Londrina: an evaluation from the perspective of the social actors involved", of the Professional Master's Program in Public Policies, from the University of the Vale do Itajaí, we made a cut focusing on the evaluations expressed by the scholarship students around the Program of Students-Graduation Agreement - PEC-G at the State University of Londrina.

The general objective of this study is to: Understand the evaluation of foreign students about the Undergraduate Students-Agreement Program (PEC-G) held at the State University of Londrina.

Thus, the PEC-G, the object of analysis of this study, is one of the instruments of educational cooperation that the Brazilian government offers to other developing countries, seeking the collectivization of access to education and more opportunities for qualification of human resources to young people from a developing country (MRE, 2016)

For the preparation of this work, it was sought to understand, through theoretical reference, the Public, Social and Educational Policies, considering the approaches and concepts necessary for an understanding of the Undergraduate Students-Agreement Program, through federal legislation, in addition to the legislations of the Institution regarding the Program, for the realization of the understanding and functioning of the

Institution in Brazilian HEIs.

Thus, the work delimits a public institution, in this case, the UEL, since the action, in this public body, is already defined with its laws and decrees. In spite of this, it needs internal actions pertinent to the understanding of the PEC-G for an institutional evaluation, providing benefits to the students, to the University, as well as to the country of origin of the students, which maintains cooperative relations with Brazil.

II. METODOLOGY

Through the Case Study of active students at UEL and the coordinators and teachers responsible for the G-PEC, the Ministry of Foreign Affairs (MRE) and the Ministry of Education (MEC) understand the evaluation of the Student Program - Undergraduate Agreement - PEC-G at the State University of Londrina by the scholarship students involved in it, inspect their conditions and proposing actions and mechanisms for improvements and adjustments to Public Policies at UEL.

This is a qualitative approach research, as a research technique, were semi-structured interviews. According to Gil (2008), the research is developed through a fixed list of questions, so that, for the accomplishment of the research, a descriptive study method was adopted, whose data collection was elaborated by documentary, bibliographic research. In it, a survey was elaborated by means of interviews and questionnaire, in which the questions remain invariable for all the interviewees - are open questions in which the respondents have their own way of writing the answers.

For the application of the questionnaire, the following criterion was observed: only questionnaires would be sent to active students, that is, enrolled and studying, totaling 29 (twenty-nine) students, while interviews with coordinators and teachers, as well as MRE managers and MEC, made 3 (three) in total.

III. THEORETICAL FRAMEWORK

3.1 Students-Undergraduate Agreement Program: PEC-G as Cooperation Program

Graduation for the PEC-G student is free, however, the student must pay for his / her housing, transportation and food expenses during the period of stay in Brazil. According to data from the MEC (BRAZIL, MEC, 2015), the selected students will be submitted to the Portuguese Course for Foreigners and the Celpe-Bras Exam in Brazil, that is, standardized tests in Portuguese developed by the Ministry of Education.

Data from the Department of Higher Education of the Ministry of Education and Culture (BRASIL, 2014) regarding the 2014-2015 selection process reveal that the most sought-after courses by foreigners in Brazil, through the PEC-G, are: Medicine, Engineering, Administration and International Relations.

In 2014, the Program has completed 50 years, and it is estimated that during that period, approximately 15 thousand young people attended. In a very effective way, the PEC-G encourages the formation of the student-covenant in the expansion of its educational level, since it selects participants between the ages of 18 and 23 who have financial conditions to stay in the place of exchange, without costs for the country of origin and destination (BRASIL, MEC, 2015).

The G-PEC includes developing countries, that is to say, economically less favored ones. For this reason, it is necessary to consider that the students, for the most part, come from families with little financial structure, but declare conditions of staying in Brazil - because this is one of the requirements of the protocol, although they do not always have these conditions (BIZON, 2013). According to Manual of the Program of Student-Graduation Agreement (PEC-G), year 2000, the student should have exclusive dedication. One of the rules prevents the members from carrying out any type of paid work, and because they receive few resources from their families, the student therefore seeks financial resources through an internship.

At present, there are 72 Higher Education Institutions (IES), which are offered to the PEC-G, offering all those approved, free admission and without a competition or entrance examination to students from 58 countries. At present, there are 25 nations in Africa, 25 in Latin America and the Caribbean and 8 in Asia. In 2015, the courses with the largest number of vacancies offered by the universities were: Letters, Social Communication, Administration, Biological Sciences and Pedagogy (DCE, 2016).

Decree 7.948, signed by the President of the Republic, Dilma Rousseff and the Ministers Antônio de Aguiar Patriota and Aloizio Mercadante, mandates the Ministry of Foreign Affairs to coordinate procedures for the implementation of the G-PEC with foreign governments through the diplomatic missions and Brazilian consular offices. In addition, it is the responsibility of the Ministry of Education to coordinate the procedures related to the admission of the HEI to the G-PEC, offer of vacancies, selection and registration of candidates and monitoring of the Program.

By 2018, the Program has been administered in

three parts: the MEC and the MRE are in charge of their overall coordination and the Higher Education Institutions (HEIs) are responsible for the reception and training of the students.

For a better understanding in this respect, according to Maciel (2010, p.6), "we must ask: what is the environment that nourishes and nurtures one's own citizenship and, by correspondence, strengthens the role of the citizen in the control of Public Policies? Obviously this place is the democratic environment. "

It means, therefore, according to the new constitutional order erected by the Federal Constitution of 1988, that, in a democratic environment, there is a great power over the constitution of Rule of Law, whose principles are organized to meet social needs. The guiding principles of the Democratic State of Law, in consonance with Streck and Morais (2000, p.90), are: "constitutionality, democracy, social justice, equality, division of powers, legality, the system of fundamental rights ".

The purpose of social rights is to enable people to have services capable of guaranteeing a minimum quality of life, providing dignified life for the citizen, that is, "represent the way in which society penetrates the State, seeking to: , to control it and to interfere in its administrative structure, in its processes of legitimation and regulation, in its priorities and objectives "(PEREIRA, 2002, p.34 apud MACIEL, 2010, p.4). Else, according to Marshall (1967), allow him to have a civilized life, that is, the state must guarantee the right to life, equality, education, immigration and emigration and association.

However, the process of winning citizens' rights is not homogeneous and linear, establishing that the recognition of citizenship does not always occur from the perspective of universality. In this bias, in the history of citizenship rights in Brazil, "many of the social rights were implemented through a corporatist bias, aiming to meet the demands of the more organized segments of the workers and with greater capacity for political pressure, and therefore did not become universal "(MACIEL, 2010, page 7 apud ARAÚJO, 1998, p.22).

Therefore, in the student-covenant relations of the PEC-G, which presents itself as a differentiated instrument of Public Policies, it is chosen the cooperation with developing countries aiming at the political-ideological commitment with the mobility of students and knowledge coming from outside of the country (BIZON, 2013).

According to the Division of Educational Issues (DCE, 2016), the idea of creating a Government Program

to support students from other countries arose from the increase in the number of foreigners in Brazil in the 1960s and the consequences that this fact brought to the internal regulation of the status of these students in Brazil. There was a need to unify the conditions of student exchange and to ensure that universities offered the same treatment given to Brazilian students. In the last 16 years, 9,218 were selected by the Program.

IV. RESULTS AND DISCUSSIONS

With regard to the PEC-G students in the UEL, 154 students have passed through the Program since its inception, of which 29 (twenty-nine) were active at the State University of Londrina at the time of this research. Thus, questionnaires were sent to 29 (twenty-nine) students, of whom 26 (twenty-six) answered, a membership of 89.66%.

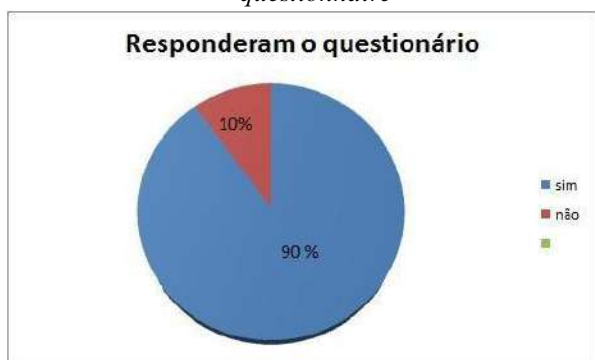
The questions presented to the social actors involved, in the form of interviews and questionnaires, led to the elaboration of this item, in which we intend to analyze the Student Program-Graduation Agreement (PEC-G). This was evaluated by those who benefited and managed the project within the Institution and by those who generally manage the G-PEC in the country through the MRE and the MEC.

4.1 Profile of students

To compose this item, the questions proposed to the students in the questionnaire were presented with the objective of evaluating how the PEC-G held at the State University of Londrina is seen by those who benefit from the Program. In this way, the graphs elaborated with the data provided by the students in the questionnaire are presented below.

Graph 4 presents the proportion (percentage) of students who answered the questionnaire.

Graph 4 – PEC-G students who completed the questionnaire



Fount: survey questionnaire data.

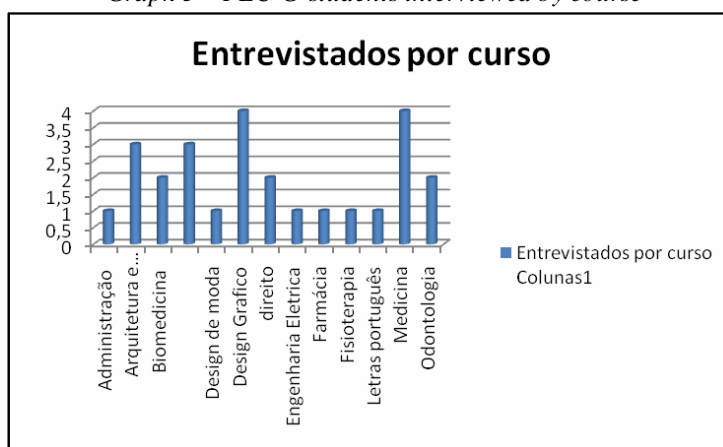
Of the 29 (twenty-nine) students interviewed, 26

(twenty-six) answered the questionnaire, making up 90% (ninety percent), three (3) of which did not respond, ie 10%). The students are willing to participate in the research and contribute to the evaluation of the program.

Of the 26 (twenty-six) participants, 17 (seventeen) are female, while 9 (nine) are male. One can notice a relevant figure in this result: the number of women is greater than that of men, that is, 65% (sixty five percent) belongs to the female sex, while only 35% (thirty five percent) to the male sex, making a total of 100% (one hundred percent) of the students interviewed.

Meanwhile, Chart 5 shows the number of students interviewed per course.

Graph 5 – PEC-G students interviewed by course



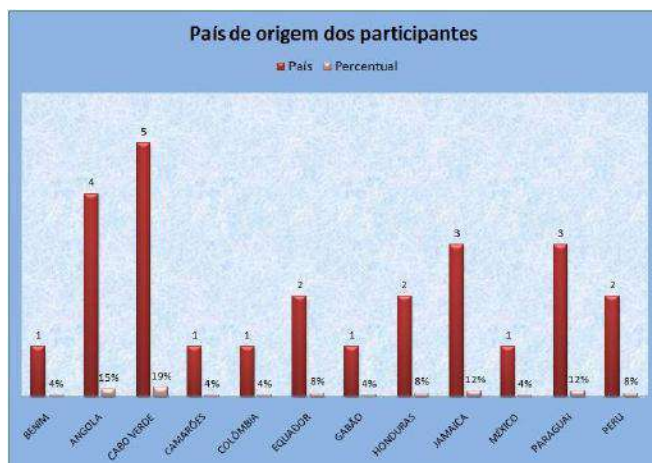
Fount: survey questionnaire data.

It is noteworthy that the largest number of students active in the act of this work was found in the courses of Medicine and Graphic Design. The largest age group in terms of percentages is 21 (twenty one) and 25 (twenty five) years, making up 19% (nineteen percent) of the total.

According to the website of the MEC (2015), the PEC-G selects participants between the ages of 18 and 23, thus, considering that UEL courses range from 4 to 6 years to completion, all students have entered the program age.

Graph 6, for its part, presents data on the proportion (percentage) of students interviewed by country.

Graph 6– Nationality of PEC-G Students Interviewed



Fount: research questionnaire.

The students who participated in this research come from several countries, with different percentages. In relation to the students coming from Africa, the percentage index stands out with a greater number of students coming from the African continent. Following the presentation of the profile of the students interviewed, the answers to the questions (6) answered in the research questionnaire were analyzed.

In question 01, “**Why did you choose the PEC-G Program and the State University of Londrina to study for graduation?**”? a table summarizing the proportion (percentage) of the reasons for the Student-Graduation Agreement (PEC-G) and UEL program choices, considering the 26 (twenty-one) answers given:

Table 5 – Choice of PEC-G and UEL

Why did choose PEC-G?	QUA	%
Opportunity for new cultures and languages	11	42
Because they did not have the intended course in their country	6	23
The program offered good and free education	5	19
Suggestion from friends or relatives	2	8
It was the best option	1	4
To know Brazil	1	4
Why did choose UEL?	QUA	%
The program put them in UEL	11	42
For being a good university and of high prestige	8	30
Single University offering the intended course	3	12
For having friends at UEL	3	12

Already knew Londrina (city)

1 4

Fount: search data.

Thus, in the choices made, 11 (eleven) students, or 42% (forty-two percent) chose to participate because they had the opportunity to leave their country and to know new cultures and languages. However, 11 (eleven) students, making up, 42% (forty-two percent) did not even know about the existence of UEL. Thus, analyzing their responses, we perceive the need for visibility of UEL outside the country, creating, in this sense, digital media dissemination strategies in several languages of the PEC-G at the State University of Londrina, contributing to the increase in demand of students in the institution.

The reasons for the choices made by PEC-G and UEL in the responses of 13 students were: "The program offered good and free education" and "Because it is a good university and a high prestige."

In this context, according to the MRE (2015), culturally, coexistence and experiences tighten the bonds between societies, meaning a culture of knowledge integration between countries. Thus, one of the objectives of the G-PEC is cooperation with developing countries, creating a differentiated instrument of Public Policy (BIZON, 2013), in which the political-ideological commitment with these foreigners is to offer quality teaching and research. These, according to Stallieri (2002), together, create conditions of development, generating quality of life of the populations and academic knowledge for a good performance in their professional formation in their country.

In question 02, "**How is your experience in the country?**" the table summarizing the proportion (percentage) of satisfaction or non-satisfaction level is presented:

Table 6 – Country Experience

How is your experience in the country?	QUANTITY	%
Great, wonderful, good.	14	54
Good	10	38
There are good and bad times	1	4
It's not what I "thought it should be"	1	4

Fount: search data.

It is observed that the acquired experiences, although they are "great" and "good" by these students, among them there are also degrees of satisfaction and

dissatisfaction and concern:

Satisfaction: 1 (one) likes to live in Brazil; 3 (three) report that the people of their contacts are kind and friendly; 1 (one) reports that they are receiving quality education.

Dissatisfaction: 2 (two) students report various difficulties such as "xenophobia, racism and other forms of prejudice";

Preoccupation: 3 (three) students report difficulty in obtaining housing / lodging / guarantor (person who secures or ensures the fulfillment of duties and obligations of another).

Although the experiences acquired by these students are considered excellent, good and wonderful, some find it difficult to live, even though the Ministry of Foreign Affairs manual contains information that every student, on condition of participating in the Program, must prove that has financial conditions to remain at the place of exchange. In addition, it must declare that it has conditions to support itself.

Another major difficulty reported by them was socialization, as many reported racism and xenophobia as problems, this is a condition that involves common prejudice in today's society, the difficulty of living with differences and hurting attitudinal accessibility. According to this research, 34% (thirty-four percent) of the students of the UEL Program come from Africa, which leads to the conclusion that this nationality needs to achieve humanized and inclusive respect in the higher education. This reality demonstrates the validity of investing in Public Policies of insertion of the black in the university.

In question 03 "What are the main difficulties in adapting?" is presented the table that summarizes with proportion (percentage) the difficulties in the adaptation by these students of the 26 (twenty six) answers given:

Table 7 – Difficulties of adaptation

Difficulties of adaptation	Quantity	
Language, idiom	6	23
Habitation	4	15
Culture difference	4	15
Racism	3	12
Reception	1	4
Adapting to the course	4	15
Culture shock	2	8
Work - Not being able to work	1	4
They had no difficulties adapting	1	4

Fount: search data

With regard to the difficulties experienced by the exchange students, the question of language is mentioned, cited several times in their answers as a difficulty; 23% (twenty-three percent) have difficulty with the language and 15% (fifteen percent) with the dwelling. It is worth remembering that the Celpe-Bras proficiency exam is applied, according to the MRE, in the student's own country if there is an Applicator Center. Otherwise, the Program directs the student, in Brazil, where there is a vacancy to take the course and proof of proficiency. In this way, HEIs understand that the student should have at least an understanding and understanding of the Portuguese language in order to leverage their studies during the exchange.

However, according to the students' reports, one of the great difficulties experienced is related to the language, there is a need to review the evaluation tools and criteria, as well as access to learning Portuguese. Some HEIs are more structured than others, and it is necessary to invest more in preparatory courses of Portuguese for foreign students, including UEL, determining institutional actions with attention directed to the Portuguese courses, being it an application or not of the Celpe- Bras.

Another point reported by students on this issue is racism, notorious in several speeches of the students in this field work, because they realized racial and intercultural disrespect. Therefore, it is necessary to institutionally review how to adapt internal regulations of the University with the purpose of enabling the opportunity of appropriate treatment of diversity to foreign students.

In the matter 4, "What are the strengths and weaknesses of PEC-G?" the table summarizing with proportion (percentage) positive and negative points is presented, considering 26 (twenty-six) given answers:

Table 8 – Positive points of PEC-G

Regarding the answers:	Quantity	%
Opportunity new culture / study in Brazil	11	42
Good welcome	2	8
Quality education	4	15
Exchange of culture / exchange of experiences	6	23
Free Teaching	2	8
Enter University without taking a test	1	4

Fount: search data

Table 9 – Negative points of PEC-G

Regarding the answers:	Quantity	%
The diploma is withdrawn in the student's country;	1	4
Lack of assistance to students before arriving in Brazil;	1	4
Financial situation	4	15
Language idiom	11	42
Missing student reception;	2	8
Very strict PEC-G legislation	1	4
Not being able to work	1	4
Hangout	4	15
Can not transfer course or university	1	4

Font: search data.

Faced with the placement of 1 (one) student: "A negative point would be the possibility of changing course or university [which] does not occur in all cases, for example, in UEL do not accept change of internal course." It is noted that according to the Clause 15 Protocol, the transfer of the student-agreement from one institution to another is at the discretion of the institutions themselves, and can be accepted with justification of this claim, provided that it meets the requirements of the HEI of destination and always in conformity with the criteria set by the Education Board of the education system. That is, according to § 1, the transfer that refers to this clause is from one HEI to the other, provided that it is a participant in the PEC-G, to continue the studies in the same course. Thus, if the original HEI accepts the transfer, it can only be attended after the conclusion of the first year of studies, not occurring according to what the student says.

In relation to the positive points, 11 (eleven) students reported the opportunity to know a new culture, and the opportunity to study in Brazil. Likewise, these students, while in Brazil, offer the Brazilian university community opportunities for cultural and social exchange. Another positive point was: "This is a very good opportunity to receive a quality education", which implies strengthening the main objective of the Program, that is, focusing on relations between governments through quality education, contributing to the development of the countries agreed by training and professional qualification for foreign students.

In this sense, Decree 7948/13, which governs the PEC-G, establishes as some obligations of the student-covenant: Do not get involved in matters of Brazilian internal and external politics; to have sufficient financial resources to support maintenance in Brazil, such as food,

transportation, housing, teaching materials, etc.; dedicate themselves exclusively to studies; not engage in paid activity that establishes employment relationship.

Therefore, upon returning to the country of origin after completing the course, if he / she fails the proficiency examination and if he / she is disconnected from the Program by the IES due to disapproval or abandonment, the student must receive his academic documents, including diploma, at the Brazilian Diplomatic Mission where he enrolled in PEC-G.

What is observed, many times, is the non-compliance with this decree. Therefore, within the negative points reported, they have: "somewhat harsh clauses that do not take into account, for example, financial and health problems". In reality, in the financial question, the students suffer a lot, because in the reports of the previous questions, many complaints are verified in this sense.

Complaints are equivalent to saying that the decree does not always correspond to their reality: either they omit information at the time of filing, or the tutor of the country of origin fails to send the stipulated amount, or the political conditions of the country can be altered in the course of the student in Brazil. All this leaves the economic condition of these students to be desired, hindering them in all aspects: housing, food, and finally, their costs in Brazil.

On the other hand, these same students do not always officialize their difficulties; the government offers Bolsa Merit and Emergency Grant, but they have to compete for them; in turn, the University offers non-curricular or non-compulsory internships that, according to Law 11.788 / 2008, must be remunerated; they can still check in their study centers possibilities of extension projects and paid education.

In addition, another fact reported was the "[...] lack of assistance to students before arriving in Brazil (with basic information such as stay and expenses in the region)." In the Student-Covenant Handbook, there is an item called "Travel Arrangements", one of the items being the address of an electronic page⁷ that contains information about Brazilian cities, in which the student can search for rent, bus, hotel etc., but this site only exists in the Portuguese language, making it difficult for those who are foreign and do not speak the language.

In addition, UEL has a Facebook page to publicize PEG-G's actions within the Institution, 8 in this way, students can check information on these social networking channels. For example, in this social network, a request for stay and help to search the bus station / airport for six students who would enter the year 2017

was announced, as well as an event about student stay and diversity. Therefore, there is a wealth of information that students can use for the purpose of entering the university context.

In the matter 5, “How do you evaluate the services provided by the State University of Londrina in relation to Infrastructure and Education”? the table summarizing the proportion (percentage) of the infrastructure question is presented, twenty-four (24) students answered, while two (2) failed to answer this question:

Table 10 – Infrastructure

Infrastructure	QUANTITY	%
Great, very good, good, normal	15	57
Old Computers and the poor Internet	4	15
Moderate	1	4
Ru – Very good university restaurant	1	4
Deplorable	1	4
Precarious	2	8
They did not answer	2	8

Fount: search data.

In terms of infrastructure: 15 (fifteen) students, that is, 57% (fifty-seven percent) of the students considered the structure to be optimal or good; 1 (one) student, that is, 4% (four percent) considered the university restaurant very good; 4 (four) students, or 15% (fifteen percent) complained about the quality of computers and Internet signal; 1 (one) student, that is, 4% (four percent) stated that the infrastructure is deplorable; 1 (one) student, that is, 4% (four percent) stated that the infrastructure is reasonable; 2 (two) students, that is, 8% (eight percent) declared the infrastructure to be precarious; 2 (two) students, that is, 8% (eight percent) did not respond. Infrastructures are points that need to be revised in order to contribute to the well-being of students, with adequate environment and digital accessibility.

In question 6, regarding the quality of teaching, “How do you evaluate the services provided by the State University of Londrina in relation to Teaching”? is presented the table that synthesizes with proportion (percentage) the evaluation of the teaching:

Table 11 – Education

Evaluate Teaching	QUANT %	ITY
Good	10	38
Optimum	3	12
Excellent	1	4
Good teachers / good	4	15
Not satisfied	3	12
Bad	1	4
Unprepared Teachers	4	15

Fount: search data.

In the teaching question: 10 (ten) students, or 38% (thirty-eight percent) answered that teaching is good; 3 (three) students, or 12% (twelve percent) considered the teaching optimal; 1 (one) student, that is, 4% (four percent) said that teaching is excellent.

In this aspect, it is necessary to consider that the University fulfills its role, offering quality of education by disseminating knowledge, since three (3) found the teaching to be good and responded by believing that when they graduate from UEL, they will leave with a good quality education, as well as considered the teaching staff of great quality. However, the student who declares "excellent" teaching believes that he does not leave the institution fully prepared for the job market, but that the university, with its academic training, opens many doors and that, with the strike, lost important contents.

Thus, at the same time that one perceives a good quality teaching, one notices that for some, teaching fails to be desired, when they affirm that, even teachers being "great", there are difficulties of understanding by cause of language, which makes learning difficult. Meanwhile, others have reported that "teaching leaves much to be desired," teachers "are not really prepared to teach some subjects." However, according to the PDI (2010-2015), the collegiate course, together with the Dean of Graduation, allows the training of PEC-G students with varied academic systems, with innovations and versatility in the curricular matrices.

In view of the above, we return to the question of reception and follow-up of these students, periodically checking their needs, creating means for students to overcome difficulties, that is, creating institutional welfare policies.

Regarding Teaching, in question 07, "In your opinion what could improve"? is presented the table that synthesizes with proportion (percentage) on what could improve:

Table 12 – Could Improve

What could improve?	QUANTIT %
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	Y	
- Strike - difficulty	2	8
- Visa renewal - bureaucracy / very high rate value	3	12
- The physical structure of the dental clinic	1	4
- More scholarship funds for PEC-G students	2	8
- Student unable to work - could review this issue (Law)	1	4
- Master's degree short-term graduation opportunity	1	4
- Make housing / UK available without selection process	1	4
- Disseminating PEC-G in the university community	1	4
- Review rules for shutdown	1	4
- In the case of UEL improving infrastructure and the PEC-G Program	1	4
- Improve the surveillance / security of the Institution	1	4
- It does not need improvement - "[...] so far, everything is fine."	1	4
- Preparation of teachers to deal with differences	1	4
- Should have more staff to deal with the G-PEC issue	1	4
- Social integration: Formal presentation students to course / language / information coordinators about housing, food, lodging / language (difficult to communicate) / racism and xenophobia / services site offered by UEL, legal and psychological support.	7	28

Font: search data.

What attracted the most attention in this item is social integration, making up a total of 28% (twenty-eight percent) of the students, highlighting some reports: communication difficulties, formal presentation to course coordinators, racism and xenophobia and legal and psychological support. However, it is noteworthy that UEL has made available these last services to the PEC -G students.

In addition, the report of 1 (one) student: "They could take the agenda of the agreement where the exchange student is forbidden to work". However, it

should be noted that the student of the PEC-G, due to the temporary visa (item IV), cannot really exercise paid activity that establishes employment relationship. However, the student may participate in curricular internship, research, extension and monitoring activities.

In general, analyzing the answers and opinions of the various students of the research, it can be observed that, for the great majority, the questions stand out: housing (that is, how to obtain a guarantor); language (how to understand and be understood); legal issues of racism, xenophobia (how to deal with such issues); presentation of students to collegiate courses for a better integration of these students; visa bureaucracy, PEC-G fellowship issues. With this, it can be stated that what is established in the decree does not always correspond to the experience of these students, after all the students of the PEC-G come to the University and there is no institutional policy to welcome these students of vulnerability.

In this way, it is possible to affirm that, when participating in the Program of Students-Graduation Agreement (PEC-G), the majority of these students, when they enter the University to attend the course in their chosen course, remain determined, remaining in the Institution and forming, even if feeling vulnerable and having to face some mishaps. Thus, they value the opportunity and the studies and the chance to have a profession in the return to the country of origin.

In general, it was also observed, during the analysis of this work, that there is little knowledge about the Program, both by the students and by the professionals involved, and it can be concluded that there is a need for institutional actions to publicize the Program. In order to make a policy, be it social, welfare, etc., it is necessary to join the services and servers instituted in the UEL within the Program and join efforts to work within the principles of ethics and socialize information, seeking the profile of this public with the objective of identify their needs, their needs. Thus, in order to make a policy, it is necessary to work together, in collaboration, in order to obtain satisfactory results with the Program within the University.

V. CONCLUSIONS

With the data gathered from the research, one can better understand the proposal of the Program and its operation in the institution, as well as, through questionnaires and interviews, one can evaluate what was said by the social actors involved. Among the students' responses, the choice of G-PEC was highlighted because of opportunities for new cultures and languages, a free

study and a prestigious university, although, in contrast, 42% (forty-two percent) of the students interviewed not meet the UEL before choosing it.

Certain difficulties in adaptation found in the reports, which constitute issues to be thought, were: housing, socialization, racism and xenophobia, according to research data. Of particular note are the language problems, where 23% (twenty-three percent) said they had difficulty with the language, while 15% (fifteen percent) with the dwelling.

Evaluating the responses, it was verified the need for UEL visibility in the country and abroad, suggesting the creation of mechanisms to disseminate the institution in digital media in several languages. And, once these mechanisms of visibility of the University and the PEC-G were created, it is assumed that there would be an increase in the demand of these students to graduate in UEL.

In the analysis of the questionnaires answered by the students, it was noticed that, when arriving in Brazil, in Londrina, and specifically in the UEL, students already feel the cultural shock and difficulties in the language, as well as changes in the food habit, difficulties of housing, so that these mishaps have contributed to the vulnerability of these students.

Education, as a right of all citizens, is a public function of the State, according to the constitution in force, however it is not only up to it, and, in the students' reports, it was observed that the fact that they did not feel inserted in the academic context makes it difficult to learn. In this case, the Institution must guarantee equal treatment in the university context, contributing to the student's academic and cultural training.

In the context of the political situation of vulnerable PEC-G students, the Institution should create a committee that works with the relevant sectors, offering possibilities to those students who have difficulties in learning. However, it is worth mentioning that there is no point in discussing Public Policy if the one who experiences the problem is not part of the discussion, that is, if the social service professional and the psychology professional, together with the relevant Rectors and Advisers to evaluate these not interact with the competent bodies to read the real situation of these students.

REFERENCES

- [1] BRAZIL. Ministry of Education. Access to the University - Foreign student. 2015. Available at: <www.mec.gov.br>. Accessed on: 14 Feb. 2016.
- [2] Ministry of Education - Capes. International Baccalaureate Program - PLI - CAPES, 2014 - FRANCE EDITAL N°. 05/2014. 2014b.
- [3] Ministry of Education. Access to the University - Foreign student. 2015. Available at: <www.mec.gov.br>. Accessed on: 14 Feb. 2016.
- [4] BIZON, Ana Cecilia Cossi. Narrating the Celpe-Bras exam and the PEC-G agreement: the construction of territorialities in times of internationalization. 2013. 415 f. Thesis (Ph.D. in Applied Linguistics) - State University of Campinas, SP, Campinas, 2013. Available at: <http://unicamp.sibi.usp.br/handle/SBURI/30788>. Access in: Jan. 13 2016.
- [5] Division of Educational Issues (DCE, 2016) [FALTA ESTA REFERÊNCIA]
- [6] DUARTE, Rafael P. United Nations Educational, Scientific and Cultural Organization (UNESCO). Ministry of Education (MEC). Secretariat of Higher Education (SESu). Department of Graduate Programs and Policies (DIPES). [FALTA DADOS, COMO O ANO]
- [7] GIL, Antonio Carlos. Methods and techniques of social research. 6. ed. São Paulo: Atlas, 2008.
- [8] HÖFLING, Eloisa de Mattos. State and (public) social policies. Cadernos Cedes, Campinas, v. 21, n. 55, p. 30-41, nov. 2001. Available at: <http://scielo.br/pdf/ccedes/v21n55/5539>. Accessed on: 17 Oct. 2016.
- [9] MACIEL, C. A. B. Public Policies and Social Control: meetings and disagreements of the Brazilian experience. Revista Intercâmbio de Congressos de Humanidades, v. 1, n. 1, 2010. Available at: <revisor10.com.br/24h/pessoa/temp/anexo/1/112/1184fb6636800a0a.doc>. Accessed on: 15 Aug. 2016.
- [10] SOUZA C. Public Policies: a literature review. Revista Sociologias, Porto Alegre, year 8, n. 16, Jul / Dec 2006.
- [11] STRECK, Lênio Luiz; MORAIS, José Luís Bolzan. Political Science and General Theory of the State. Porto Alegre: Bookstore of the Lawyer, 2000.

Tratamentos Pré Germinativos Na Germinação De Sementes De Cacau

Pre Germinating Treatments on Germination of Cocoa Seeds

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Resumo— O conhecimento das condições ideais para germinação da semente é fator importante para que possamos garantir uma produção uniforme de mudas de qualidade com garantia de estabelecimento do stand no campo de produção. Objetivou-se avaliar diferentes tratamentos térmicos, hormonal e nutricional na germinação e vigor de sementes de cacau (*Theobroma cacao* L.). O experimento foi conduzido no Laboratório de Sementes do IFES Campus - Santa Teresa e os tratamentos utilizados foram imersão durante 30 minutos em água nas temperaturas de 0°C, 25°C, 50°C, 75°C, água de coco; solução de cloreto de potássio e solução de giberelina. Cada tratamento foi composto de 4 repetições, com 25 sementes por repetição. Avaliou-se a porcentagem de germinação, índice de velocidade de germinação; tempo médio de germinação e o vigor das sementes foi avaliado por meio do comprimento de parte aérea e de radícula, matéria fresca e matéria seca das plântulas. Os tratamentos térmicos que proporcionaram os melhores resultados de vigor nas sementes de cacau respectivamente foram imersão em água a 50°C e água a 25°C. O tratamento com imersão em solução de giberelina (2000 mg.L⁻¹) 30 minutos, apresentou os melhores resultados, sendo recomendado para semente de cacau.

Palavras chave— Vigor. Plântula. Laboratório.

Abstract— Knowing the ideal conditions for seed germination is an important factor so that we can guarantee a uniform production of quality seedlings with guarantee of establishment of the stand in the field of production. The objective was to evaluate different thermal, hormonal and nutritional treatments on the germination and vigor of cocoa seeds (*Theobroma cacao* L.). The experiment was conducted in the Seeds Laboratory of the IFES Campus - Santa Teresa and the treatments used were immersion for 30 minutes in water at temperatures of 0 ° C, 25 ° C, 50 ° C, 75 ° C, coconut water; solution of potassium chloride and gibberellin solution. Each treatment was composed of 4 replicates, with 25 seeds per replicate. The percentage of germination, germination speed index; mean germination time and seed vigor was evaluated by aerial part length and radicle, fresh matter and dry matter of the seedlings. The heat treatments that gave the best results of vigor in the cocoa seeds respectively were immersion in water at 50°C and water at 25°C. The treatment with immersion in gibberellin solution (2000 mg.L⁻¹) 30 minutes, presented the best results, being recommended for cocoa bean.

Keywords— Vigor. Seedling. Laboratory.

I. INTRODUÇÃO

Originário da América Central e do Sul, o cacauzeiro (*Theobroma cacao* L.) é uma árvore tropical e de clima úmido, que produz anualmente de 0,5 a 2 kg de sementes, já fermentadas e secadas, por árvore (Medeiros et Al. 2010). Tem um valor econômico bastante relevante, pois através do cacau é feito o chocolate, por meio da moagem de suas amêndoas secas em processo industrial ou caseiro, gerando também outros subprodutos com a polpa, tendo os seus resíduos utilizados como adubo e ração para os animais.

Pertence à ordem Malvales, família Malvaceae, gênero *Theobroma*, espécie *Theobroma cacao* L., única utilizada comercialmente para a produção de chocolate. Os astecas e outros grupos de língua nahuatl denominavam o cacauzeiro de “cacaohoaquahuitl”, os frutos de “cachocentli” e suas sementes de “cacaoatl”, nome utilizado atualmente para a espécie. Em 1737, Lineu denomina o gênero de *Theobroma*, que significa alimento dos deuses, em referência à origem divina atribuída ao cacauzeiro pelos povos mesoamericanos (Efraim, 2009; Lopes et al, 2011).

O fruto do cacaueteiro tem forma oval com 15 a 20 cm de comprimento do eixo maior, e cor amarela quando maduro. O cotilédone e um pequeno gérmen de planta embrionária são recobertos por uma película denominada testa, e a semente é revestida por uma polpa branca com tons rosados, mucilagínosa e adocicada (Batalha, 2009).

Planta de clima quente e úmido o cacaueteiro pode ter sua propagação de forma vegetativa (assexuada) e por sementes (seminal/ sexuada). A qualidade das sementes, bem como a capacidade de produzir plântulas normais, é expressa pelo teste de germinação. Cada espécie exige determinadas condições de germinação, nas quais suas sementes conseguem expressar o máximo potencial de vigor (Garcia, 1994).

As sementes desenvolveram métodos eficientes, ao longo do tempo, não somente sensores capazes de sentirem o ambiente a sua volta, mas também o seu histórico de desenvolvimento evolutivo que são capazes de regular a sua dormência fisiológica e a inibição da germinação (Kendallet et al., 2011; Kendall & Penfield, 2012; Penfield & Springthorpe, 2012; He et al., 2014; Huang et al., 2014) tais sinais vão determinar o tempo e o local de germinação das sementes (Footitt et al., 2011, Footitt et al., 2013, Footitt et al., 2014). Sendo uma semente recalcitrante o cacauete tolera apenas uma pequena perda de água através de secagem e apresenta taxa de germinação moderada na ausência de água adicional.

O processo germinação de sementes de um mesmo lote pode estar em diferentes fases da curva de embebição, fazendo com que a germinação não aconteça de forma homogeneia. Uma pré-embebição em água ou em uma solução de potencial osmótico conhecido, durante intervalo de tempo e temperatura determinados, permiti o controle da disponibilidade hídrica, (Tonin, 2005) sendo uma forma de acelerar o processo de germinação.

O conhecimento das condições ideais para germinação da semente é fator importante para que possamos garantir uma produção uniforme de mudas de qualidade com garantia de estabelecimento do stand no campo de produção.

O objetivo da pesquisa foi avaliar a germinação e o vigor das sementes de cacauete em diferentes tratamentos térmico, fontes de nutrientes e hormonal.

II. MATERIAL E METODOS

O experimento foi conduzido no Laboratório de Tecnologia e Produção de Sementes do Instituto Federal do Espírito Santo *Campus* - Santa Teresa que se localiza na Região Centro Serrana do Estado de Espírito Santo.

Os frutos da variedade clonal PS-1319 foram adquiridas na fazenda experimental da CEPLAC,

localizada no município de Linhares. Foi realizada a extração das sementes, imersas em uma solução de cal virgem durante 1 minuto e depois enxaguadas em água corrente, para retirar o excesso da mucilagem. Logo após, as sementes foram colocadas em contato com uma mistura contendo pó de serra e areia, e friccionando com cuidado para retirada do restante da mucilagem, lavando-as novamente para retirar a mistura.

As sementes foram postas sobre folhas de jornal e colocadas para secar a sombra durante o período de 24 horas.

O Delineamento experimental utilizado foi em blocos casualizados onde os tratamentos foram compostos por diferentes temperaturas, 0°C, 25°C, 50°C, 75°C, tratamento nutricional com solução de cloreto de potássio (50 g.L⁻¹) e água de coco, tratamento hormonal com solução de ácido giberelina (2000 mg.L⁻¹). O tempo de imersão das sementes foi fixado em 30 minutos para todos os tratamentos. Foi utilizado quatro repetições de cada tratamento, no qual cada amostra de continham 50 sementes distribuída entre três folhas de papel germitest umedecida com água destilada, equivalente a duas vezes e meia o peso do substrato seco, colocados em BOD a 25°C, com presença de luz.

O teste de germinação foi conduzido conforme Brasil (2009), sendo a primeira avaliação da germinação realizada aos quatro dias, avaliando-se diariamente para obter a porcentagem de germinação (G), índice de velocidade de germinação (IVG) (Maguire, 1962); tempo médio de germinação (TMG) (Laboriau & Valadares, 1976). O vigor das sementes foi avaliado por meio do comprimento de parte aérea (CA) e de radícula (CR), matéria fresca (MFP) e matéria seca das plântulas (MSP).

Os dados experimentais foram submetidos à análise de variância, atendendo as pressuposições do modelo pelo teste de Shapiro-Wilk para verificação da normalidade e as médias dos tratamentos foram comparadas pelo teste Tukey em nível de 5% de probabilidade.

III. RESULTADOS E DISCUSSÃO

Nos tratamentos em que as sementes foram embebidas em diferentes temperaturas, observou-se que houve diferença significativa entre as mesmas, sendo apenas os tratamentos com água a 25°C e 50°C apresentaram maior representatividade, mostrando a influência da temperatura na germinação (Tabela 1). Os valores no que dizem respeito ao Índice de velocidade de germinação, e Tempo médio de germinação também demonstram os mesmos resultados com diferença significativa em relação aos outros tratamentos térmicos.

O comportamento nos tratamentos com temperaturas de 0°C e 75°C, não apresentaram resultados satisfatórios nos testes ligados a germinação. Como a temperatura vai aos extremos nesses tratamentos, danos nas membranas e no funcionamento nas sementes podem ter acontecidos. As altas temperaturas podem ter afetado os tecidos do eixo embrionário, com consequências que podem ter culminado na redução da germinação ou até mesmo, na morte do embrião. Os resultados obtidos nas temperaturas de 25 e 50°C demonstram que o tempo de embebição das sementes favoreceu no desempenho da germinação das sementes de cacau.

Brancaion et al. (2010), trabalhando com espécies arbóreas, cita que a temperatura de 25 °C é ótima para a germinação das sementes da maioria das espécies arbóreas brasileiras, seguida por 30 °C. Analisadas em

conjunto, as temperaturas 25 °C e, ou, 30 °C representaram 90,4% das indicações de temperaturas ótimas para a germinação das sementes, de forma que as mesmas puderam ser consideradas como as que mais favorecem o processo germinativo das espécies.

Carreiro et al. (2010) verificaram que os tratamentos com água quente à 50°C e à 60°C promoveram uma maior porcentagem de germinação e maior uniformidade; já a 70°C houve uma queda no percentual de germinação.

Quando utilizamos tratamentos hormonais ou com fontes de nutrientes, não foi observada diferença significativa para germinação, porém a giberelina apresentou-se IVG e TMG com os maiores tempos na velocidade de germinação e menores no tempo médio de germinação (Tabela 1).

Tabela 1 – Média dos tratamentos para germinação e vigor em sementes de cacau

Trat	G	IVG	TMG	CA	CR	MFP	MSP
1	38 bc	1,536 c	7,709ab	3,81 ab	25,79 a	3,686 h	9,48 h
2	98 a	4,454 a	6,628bc	5,69 a	26,46 a	44,022 d	10,24 c
3	100 a	4,824 a	6,18 bc	5,9 a	27,78 a	44,784 b	10,66 b
4	58 b	2,883 b	5,949 c	5,41 a	25,2 a	44,556 c	9,52 g
5	98 a	4,379 a	6,960 bc	0,65 bc	12,05 b	35,758 f	9,96 e
6	100 a	3,286 b	8,52 a	0,6bc	9,33 b	32,504 g	9,57 f
7	100 a	4,866 a	6,117 bc	5,5 a	23,21 a	51,190 a	11,17 a

Médias dos tratamentos, seguidas da mesma letra na coluna para cada variável, não diferem entre si pelo teste Tukey em nível de 5% de probabilidade.

G = Germinação (%); IVG = Índice de Velocidade de Germinação; TMG = Tempo Médio de Germinação; CP = Comprimento da parte aérea; CR = Comprimento de Raiz; MFP = Matéria Fresca da Planta; MSP = Matéria Seca da Planta. Trat. 1 = Água 0°C; Trat. 2 = Água 25°C; Trat. 3 = Água 50°C; Trat. 4 = Água 75°C; Trat. 5 = Água de Coco; Trat. 5 = Cloreto de Potássio; Trat.7 = Giberelina.

Quando analisado os dados que dizem respeito ao vigor das sementes que foram tratadas com as diferentes temperaturas de água através dos valores de comprimento da parte aérea e comprimento da raiz, os tratamentos nas diferentes temperaturas e com giberelina não apresentaram diferença significativa entre si, porém o tratamento com água de coco e cloreto de potássio apresentaram-se bastante inferiores aos demais tratamentos (Tabela 1).

As variáveis Massa Fresca e Massa Seca da Planta foram superiores no tratamento com Giberelina, comparado aos outros tratamentos. A Água de Coco apesar de ter proporcionado uma boa germinação, foi insatisfatória nas outras avaliações, ainda que esta, com características hidratantes, não foi bem assimilada pela semente de cacau.

O Tratamento com água 0°C (gelo), não apresentou bons resultados para semente de cacau, fato

que deve ser citado como desaconselhável para semente de cacau.

O ácido giberélico possui extrema importância na germinação por agir na quebra de dormência controlando a hidrólise de reservas que estão relacionadas ao crescimento e desenvolvimento do embrião, comprovando os melhores resultados encontrados neste trabalho.

Guimarães et al. (2010) trabalhando com sementes de *Thlaspi caerulescens* J. Presl & C. Presl demonstraram que o uso de GA3 foi benéfico, por promover maiores porcentagens de germinação e maiores índices de velocidade de emergência. Também Peixoto et al. (2011) encontraram resultados positivos quando aplicada na pré-embebição de sementes de mamona, estimulando a porcentagem de primeira contagem de emergência, índice de velocidade de emergência e porcentagem de emergência, além de

proporcionar incremento significativo no comprimento de raiz e de parte aérea, bem como no acúmulo de massa seca da raiz, parte aérea e total das plântulas.

Prado (2006) observou que a pré- embebição de sementes de jenipapeiro por 12 horas em solução de giberelina nas concentrações de (50, 100 e 200 mL.L⁻¹), proporcionam maiores índices de velocidade de germinação de sementes. Santos Filho (2007) cita que o índice de velocidade de germinação e o índice de velocidade de emergência em sementes de graviola, foram aumentados com o uso da solução de giberelina.

Prado (2006) verificou que o regulador à base de ácido giberélico foi eficiente na indução do comprimento de raiz e comprimento total de plântulas de jenipapeiro. Na cultura do milho, a aplicação de giberelina (GA3) pulverizado sob as plantas de milho normal e anão, ocasionou o alongamento das plantas de milho anão e, conseqüentemente, aumento da estatura (Taiz & Zeiger, 2013).

IV. CONCLUSÃO

Os tratamentos térmicos que proporciona os melhores resultados de vigor nas sementes de cacau respectivamente foram imersão em água a 50°C e água a 25°C por 30 minutos.

O tratamento com imersão das sementes em solução de ácido giberélico-Ga3(2000 mg.L⁻¹) 30 minutos, apresentou os melhores resultados, sendo recomendado para semente de cacau.

REFERÊNCIAS

- [1] BATALHA, P. G. **Caracterização do cacau Catongo de São Tomé e Príncipe**. Lisboa. Mestrado (Mestre em Engenharia de Alimentos – Tecnologia de Produtos vegetais) Universidade Técnica de Lisboa. Instituto Superior de Agronomia. Lisboa – Portugal, 2009.
- [2] BRANCALION, P. H. S.; NOVENBRE, A. D. L. C.; RODRIGUES, R. R. Temperatura ótima de germinação de sementes de espécies arbóreas brasileiras. **Revista Brasileira de Sementes**, Londrina, v.32, n.4, p.15-21, 2010.
- [3] BRASIL. Ministério da Agricultura. **Regras para análise de sementes**. Brasília, 2009. 398 p.
- [4] CARNEIRO, G. G.; BARBOSA, J. A.; SILVA, E. O.; GOIS, G. C.; LUCENA, H. H.; ALVES, E. U. *Bioscience Journal*, Germinação de pimentas cambuci submetidas à superação de dormência em água quente. Uberlândia, v. 26, n. 6, p. 882-885, Dez. 2010.
- [5] EFRAIM, P. **Contribuição à melhoria de qualidade de produtos de cacau no Brasil, através da caracterização de derivados de cultivares resistentes à vassoura-de-bruxa e de sementes danificadas pelo fungo**. Campinas. Tese (Doutorado em Tecnologia de Alimentos). Faculdade de Engenharia de Alimentos, Universidade Estadual de Campinas, 2009.
- [6] FOOTITT, S.; DOUTERRELO-SOLER, I.; CLAY, H.; FINCH-SAVAGE, W.E. Dormancy cycling in Arabidopsis seeds is controlled by seasonally distinct hormone-signaling pathways. **Proceedings of the National Academy of Sciences, USA** 108, 20236– 20241, 2011.
- [7] FOOTITT, S.; HUANG, Z.Y.; CLAY, H.A.; MEAD, A.;FINCH-SAVAGE, W.E. Temperature, light and nitrate sensing coordinate Arabidopsis seed dormancy cycling, resulting in winter and summer annual phenotypes. **Plant Journal**, 74, 1003– 1015, 2013.
- [8] FOOTITT, S.; CLAY, H.A.; DENT, K. ;FINCH-SAVAGE, W.E. Environment sensing in spring-dispersed seeds of a winter annual Arabidopsis influences the regulation of dormancy to align germination potential with seasonal changes. **New Phytologist**, 202, 929–939, 2014.
- [9] GARCIA, L. C. Influência da temperatura na germinação de sementes e no vigor de plântulas de cupuaçuzeiro (*Theobroma grandiflorum* (Wild. Ex-Spreng) Schum.). **Pesquisa Agropecuária Brasileira**, V29, n. 7, p. 1145-1150, 1994.
- [10] GUIMARÃES, M.A.; VIDIGAL, D. S.; LOUREIRO, M. E.; DIAS, D. C. F.S.; GUIMARÃES, A. R. Influência de temperatura, luz e giberelina na germinação de sementes de *Thlaspi caerulescens* J. Presl & C. Presl (Brassicaceae) **Revista Ceres**, Viçosa, v. 57, n.3, p. 372-376, mai/jun, 2010.
- [11] HE, H.; DE SOUZA VIDIGAL, D., SNOEK, L.B.; SCHNABEL, S.; NIJVEEN, H.; HILHORST, H. ; BENTSINK, L. Interaction between parental environment and genotype affects plant and seed performance in Arabidopsis. **Journal of Experimental Botany**, 65, 6603–6615, 2014.
- [12] HUANG, Z.; FOOTITT, S.;FINCH-SAVAGE, W.E. The effect of temperature on reproduction in the summer and winter annual Arabidopsis thaliana ecotypes Bur and Cvi. **Annals of Botany**, 113, 921– 929, 2014.
- [13] KENDALL, S. ; PENFIELD, S. Maternal and zygotic temperature signalling in the control of seed

- dormancy and germination. **Seed Science Research**, 22, S23–S29, 2012.
- [14] KENDALL, S.L.; HELLWEGE, A.; MARRIOT, P.; WHALLEY, C.; GRAHAM, I.A.; PENFIELD, S. Induction of dormancy in Arabidopsis summer annuals requires parallel regulation of DOG1 and hormone metabolism by low temperature and CBF transcription factors. **Plant Cell**, 23, 2568–2580, 2011.
- [15] LABOURIAU, L. G.; VALADARES, M. E. B. On the germination of seeds *Calotropis procera*(Ait.). **Anais da Academia Brasileira de Ciências**, v.48, n.2, p.263-284, 1976.
- [16] LOPES, U. V.; MONTEIRO, W. R.; PIRES, J. L.; CLEMENT, D.; YAMADA, M. M.; GRAMACHO, K. P. Cacao breeding in Bahia, Brasil - strategies and results. **Crop Breeding and Applied Biotechnology**, v. 1, p. 73-81, 2011.
- [17] MAGUIRE, J. D. Speed of germination – aid in selection and evolution for seedling emergence and vigor. **Crop Science**, v.2, n.2, p.176-177, 1962.
- [18] MEDEIROS, M. L.; LANNES, S. C. S. Propriedades físicas de substitutos do cacau. **Cienc Tecnol Aliment**, v. 30, n. 1, p. 243-53, 2010.
- [19] PEIXOTO, C. P.; SALES, F.J. S.; VIEIRA, E. L.; PASSOS, A. R.; SANTOS, J. M.S. Ação da giberelina em sementes pré-embebidas de mamoneira. **Comunicata Scientiae**, Teresina 2(2): 70-75, 2011.
- [20] PENFIELD, S. ; SPRINGTHORPE, V. Understanding chilling responses in Arabidopsis seeds and their contribution to life history. **Philosophical Transactions of the Royal Society B – Biological Sciences**, 367, 291–297, 2012.
- [21] PRADO, M. **Germinação de sementes e enxertia de jenipapeiro**. 46f. (Dissertação de Mestrado) – Universidade Federal da Bahia, Cruz das Almas, Brasil. 2006.
- [22] SANTOS FILHO, A. L. **Germinação de sementes, estaquia e enxertia em gravioleira** (*Annona muricata* L.). 50f. (Dissertação de Mestrado) – Universidade Federal da Bahia, Cruz das Almas, Brasil. 2007.
- [23] TAIZ, L.; ZEIGER, E. **Giberelinas**: reguladores da altura dos vegetais. Fisiologia vegetal. 5.ed. Porto Alegre: Artmed: 2013. 488p.
- [24] TONIN, G. A. et al. Influência da temperatura de condicionamento osmótico na viabilidade e no vigor de sementes de *Pterogyne nitens* Tull. **Revista Brasileira de Sementes**, Londrina, v. 27, n. 2, p. 35-43, 2005.

Introduction of Agro-Ecological Systems in the Municipality of Exu-Pe

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Abstract— *Agroecology has led us to think a lot far beyond the immediate results of our actions, and it makes us reflect on what they mean about all beings that share the same environment, breathe the same air and share a unique biosphere. Based on agroecological principles, organic farming yields food without toxic waste, guaranteeing a healthy diet in our homes. It is necessary to consider that agroecology is a practice that does not affect the health of the farmers or the ecosystems. This paper presents bibliographic research regarding the questions about agroecology, its characteristics, and the importance of the action of man in work with the practice in question. It aims to achieve a better quality of life in the environment in which we live, as well as healthy nurture, caring for the environment, preserving the ecosystem, making more understandable the importance of agroecology for the quality of life of a society.*

Keywords— *Agroecology, Life quality, Semiarid zones*

I. INTRODUCTION

The main objective of this work is to verify which agro-ecological practices are carried out in the municipality of Exu-PE, in the region of Chapada do Araripe. The central focus of the analysis will be to verify whether the methods used to present an agroecological production.

The origin of this problem is related to the observations of the methods of agricultural production in the city. Since the main foundation of agroecology is to cultivate agriculture that does not affect the environment, but instead develops mutually, so that one favors the other as opposed to conventional agriculture. In this way, I intend to investigate whether there has been a change in the production methods used in the Lermen family's estate.

With this study, we intend to understand and explain the scenario of agroecological production in the semiarid region, addressing aspects related to the climate of the Chapada (plateau) do Araripe. The study was conducted through bibliographic research and brought a record of agricultural production methods from the beginning to the recent agroecology. The emergence of agroecology took place through the evolution of the thoughts and concerns of the people involved in activities related to the environment, to the soil and the agriculture as a whole (ASSIS, 2006).

In the Brazilian context, the concept of agroecology

emerged through the creation of non-governmental organizations in the early 80s years. Nowadays, this concept is present in all regions of the country, especially among small communities, in addition to involving a considerable amount of scientists, academics and scholars from various areas (Santos *et al.*, 2014).

Regarding the semiarid region, social representations most often appear associated with a hostile and inadequate landscape for any productive activity. However, when considering this environment in a more attentive way, despite the climatic seasonality existing in the eco-regions, there is a broad biological potentiality of the agroecosystems that are composed in the caatinga biome. In this biome, the main problem is the scarcity of water, and so the crops are so impaired (VIEIRA-FILHO, *et al.*, 2016).

In the municipality of Exu, some communities practice agroecology. Among them is Baixo do Meio, Serra do Ingá and Serra da Refrigera with a production, basically of vegetables and fruit trees. However, the community with the highest expressiveness is the Lermen family, in the Serra (mountain) dos Paus Doías. Another aspect that is addressed in the text is the influence of civil society organizations, for the implementation of agroecology in this region.

II. AGROECOLOGY IN BRAZIL

Agroecology can be understood as the ecological

management of natural resources, through forms of collective social action, participative development from production to the final product, establishing relationships between production and consumption. In this sense, agroecology does not exist alone, since it is integrating science, aggregating knowledge of other sciences, such as ecology, available expertise and traditional knowledge from the experiences of rural farmers (CAPORAL, 2004).

It is important to emphasize that the primary foundation of agroecology is to plant, which does not affect the environment, developing mutually one favoring the other, unlike conventional agriculture that considers little for the environment (CAPORAL, 2007).

Agroecology emerged in the decade of 1970, to constitute a theoretical basis for different movements of alternative agriculture that were strengthening with the exhaustion of modern agriculture. Although the term has arisen along with the various currents of alternative farming, it cannot be understood as an agricultural method. Agroecology is a science that seeks to understand the functioning of complex agroecosystems, as well as the different interactions found in them, with the main foundation of preserving and expanding the biodiversity of Agricultural systems as support to produce self-regulation and therefore sustainability (ASSIS, 2005).

III. UPRAISING OF AGROECOLOGY IN BRAZIL

Agriculture has always been part of the observations of people seeking improvements in the exercise of the activity. Thus, it causes an actual process of accumulated information making agricultural technologies evolving and diminishing environmental constraints (ASSIS, 2006).

Since the colonial period, problems related to the environment have been observed, more specifically deforestation and soil conservation, caused by the production system in monoculture systems. According Aurelio's dictionary: "*monoculture is the exclusive culture of an agricultural product.*" Although people were aware of the environmental degradation caused by this specific mode of production only in the mid-60 and 70, they decided to seek solutions to these ecological problems (DE DEUS; BAKONYI, 2012). In this context, Assis (2005) elucidates that, from the characterization of these problems, alternative farming movements to the currently predominant production model ceased to elicit in their opponents the relentless discourse that would represent a return to the past.

Even during those decades, it is possible to identify the initial concerns regarding environmental preservation.

From there it has increased the fears of the inclusion of anthropogenic activities with soil, fauna, water resources, flora, and ecosystems, forcing these activities not to cause irreparable losses to the environment and result in safe food for those involved in this process (MONASTÉRIO; MELO; SOARES, 2014).

At this point, it is evident that the emergence of agroecology took place through the evolution of the thoughts and concerns of the people involved in activities related to the environment, the soil and the agriculture as a whole. Thus, it is understood that it was through searches for improvements in production and better quality in the final product for their consumption that people began to practice agricultural activity sustainably (BRASILEIRO, 2009).

Agroecology is, therefore, the result of the evolution of agricultural practices developed through observations and researches of all those involved in agricultural activities in search of more sustainable production. However, it is essential to clarify that some authors do not consider agroecology a science because it gathers the knowledge of common sense that, by definition, is not scientific. Thus, it is possible to understand that the explanations about the concept of agroecology are not yet very well determined since there is disagreement between the opinions of some authors (SANTOS *et al.*, 2014).

Feiden (2005) explains that:

(...) agroecology is science under construction, with transdisciplinary characteristics integrating the knowledge of several other sciences and including, traditional culture, but this is validated employing scientific methodologies (even though sometimes it is non-conventional methods).

Agroecology is also considered alternative agriculture because this term is used to define a means of production in which the environment and the soil are not harmed, thus maintaining the health of producers and consumers. At this point, it is indispensable to mention that over the years, different segments emerged for this practice. They are organic farming, biology, natural, biodynamic, and permaculture (FINATTO; SALAMONI, 2008).

- *Organic agriculture*: It is a productive process wrapped with the consistency and sanity of the culture of live food to ensure the health of human beings, for this reason, uses and develops technologies corresponding to the local reality of soil, climate, water, topography, radiations, and biodiversity of each context;

- *Biological agriculture*: It is a mode of cultivation that aims to produce high-quality food and textile fibers while

promoting sustainable and positive impact techniques in the agricultural ecosystem;

- *Natural agriculture* was developed by Mokiti Okada (1882-1955), this method recommends natural cultivation where there is the harmony of the environment, with food, with the health of man, and with spirituality;
- *Biodynamic agriculture*: It is very similar to organic agriculture, treats soil fertility, plant growth and livestock care as ecologically interrelated tasks highlighting the spiritual and mystical perspectives;
- *Permaculture*: A culture that encompasses holistic methods to plan, update, and maintain human scale systems (gardens, villages, and communities) environmentally sustainable, socially fair, and financially viable.

In Brazil, the concept of agroecology emerged through the creation of non-governmental organizations (NGOs), at the beginning of the years 1980. Today, this concept is present in all regions of the country, mainly amongst small communities and settlements, in addition to involving a considerable amount of scientists, academics and scholars from various areas (NODARI; GUERRA, 2015). In regions such as Rio Grande do Sul, Santa Catarina, and São Paulo it has already been implemented agroecological techniques in the crops. From the information provided by the national policy of technical assistance and agricultural extension, an expansion of agroecological activities that occur thanks to the organized extension practices. These activities obtained a considerable increase in Brazilian soil (NOTAROBERTO *et al.*, 2017).

In most Brazilian states, there are already programs focused on agroecology, quality of life, and conservation of the environment (AZEVEDO; PELICIONI, 2011).

IV. INTRODUCTION OF AGROECOLOGY IN NORTHEAST SEMI-ARID

The Brazilian semiarid has many chances of becoming a significant producer of organic foods. This region covers an area of 975,000 sq.km, formed by ten federative states. Formerly the semiarid was seen as an unproductive field. However, this time has remained in the past; today, the producers claim that the land is fertile and productive. Thus, non-governmental organizations want to disseminate agroecology to the individual farmer, with greater precision in the communities of family farmers (MAZZOLENI; NOGUEIRA, 2006).

The northeastern region of Brazil, particularly the region corresponding to the semiarid, has been seen over the years as a "problem region", in which the different and recurrent forms of state intervention did not obtain

the expected results, in relation to social issues and their resolutions: expressive income inequality, poor living conditions, low levels of employment and income, among others, which mainly affect the rural population.

We observed several experiences in the semiarid, through communities that seek a means of producing healthy foods, through practices with agroecological principles. In this sense, Silveira (2002) argues that: Overcoming the problems experienced by family farming in regions with water scarcity requires the incorporation of innovations related to agricultural management, which allow achieving a growing balance between the intensification of space use and the regeneration capacity of biophysical conditions that subside the fertility of agroecosystems.

When observing the approaches superficially concerning the agricultural cultivation in the semiarid region of the Northeast, social representations most often appear associated with a hostile and inadequate landscape for any productive activity. However, when considering this environment in a more attentive way, despite the climatic seasonality existing in the eco-regions, there is a broad biological potentiality of agro-ecosystems that are composed in the caatinga biome (VIEIRA-FILHO *et al.*, 2016).

Concerning the context of these semiarid regions, it is indispensable to mention that the primary source of water is from rains, these, in turn, are scarce and irregular. This way, Curado, and collaborators report (2014): In this brief characterization of the semiarid region and adjacencies, it can be affirmed that its primary input is rainwater. These rains are distributed in an irregular uncertain way. However, families depend on regularity in the satisfaction of a series of water demands for human consumption, domestic, for supply to animals and agriculture.

In the semiarid regions with the most significant number of inhabitants, addressing the problems of access to water resources is essential to overcoming obstacles to development. Thus, public policies need to be established to insert appropriate infrastructure to provide adequate water to ensure the animal and human supply, besides assisting in irrigation (SILVA *et al.*, 2016).

In this way, public policies work in two ways: building large reservoirs (in this case the dams) with a capacity of billions of cubic meters, which are found in small quantities in some states; and with small reservoirs of capacity of thousands of cubic meters, these being found in the whole region. We can still highlight the cisterns and wells, which also work like other forms of water storage in the rural environment (ASSUNÇÃO;

LIVINGSTONE, 1993). This number of reservoirs has been growing thanks to the efforts of municipalities and communities in general, but compared to rural needs, this number is still insufficient to meet all local requirements. In this sense, Silva (2007) explains that:

One of the great misconceptions of the actions of “combating drought” by Governments relates to their fragmented and reductionist vision that identifies the lack of water as the main problem to face. Thus, it refers to the need for a new reading that brings the hinterland man closer to nature, with a holistic and ecological approach, perceiving this interrelationship as a fundamental element in the social and cultural processes in the semiarid region. Still, in this line of Reasoning, Silva (2007) mentions that:

Articulated to the emergence of a new sustainability paradigm, there are changes in the conceptions and perspectives of intervention in the Brazilian Semiarid, as space where it is possible to construct or rescue relations of coexistence based on sustainability quality of life of the country's families and encouraging appropriate economic activities. The protagonist in the affirmation of this new paradigm does not belong to Governments or dominant regional groups. The original formulators of the proposal of coexistence are civil society organizations and some public agencies of research and extension that work in the semiarid. These actors have been putting the challenge of influencing and disputing the processes of formulating public policies in the region.

Besides, this semiarid vegetation requires a brief analysis of the predominant factors of this caatinga landscape. In turn is a biome with high biodiversity, in which it stands out the plant formation xerophytes, with small leaves that decrease the transpiration with moist stems to store water and roots scattered to capture the maximum water in the period of rains (Tróleis, Santos, 2011). In addition to cacti, arboreal, herbaceous and shrubby species stand out, some of which are endemic. With the arrival of the first rains, the Caatinga loses its dry appearance giving way to a green and flowered landscape. This phenomenon serves as an inspiration for the most diverse manifestations of northeastern culture (BRASIL, 2009).

For example, the poet Patativa do Assaré in his work “A Festa da Natureza” cites: “Arriving the time of winter everything is loving and tender, meaning the eternal father his infinite goodness. Our beloved, burninated naked, is soon transformed into the most beautiful garden.”

However, the Brazilian semiarid has very complex characteristics, both with human occupation and

geophysical aspects, the deceive of its natural resources and even concerning the climate, which is shown with significant differences. In this context, Ab'Sáber (2003) highlights that:

At the beginning of the decade of 1970, the existence of four regional bands within the semiarid: the semiarid bands accentuated or sub-desert (known as “wild hinterland”); the typical semiarid or semiarid bands (the “High Hinterlands”); Moderate semiarid bands (harshly caatingas); and the transitional subareas or subsumed tracks (the harsh lands).

Due to the lack of knowledge of such particularities of this vegetation, agricultural practices lead to degradation causing environmental inequity. In this context, studies conducted by the Ministry of Environment indicate that 68% of the caatinga biome area is anthropic, being 35.3% extremely anthropized (SILVA, 2003). The zoning carried out by the Brazilian Agro-livestock Company (EMBRAPA), of 1993, revealed that the semiarid, about 16 million hectares (16% of the total) with good agricultural potential, 43 million hectares (44%) with limited agricultural potential but likely to be exploited under certain conditions, and about 35 million hectares (36%) with substantial restrictions on agrarian use (VAINER *et al.*, 2002).

To achieve success with this agroecological cultivation, it is necessary to have several cares, the main of which is the zeal with the soil, its recovery, and the maintenance of its natural equilibrium. According to Almeida (1998):

(...) we need to develop and apply creative solutions to minimize the use of industrialized inputs and maximize the use of natural resources, based on the concern with erosion control and the conservation of fertility and biota of the soil/plant system.

The soil is being recognized as a living entity, where the beings present not only depend on physical or chemical conditions, besides interfering with their large scale of practices (ARAÚJO, 2002). The Northeastern family farming is marked by its significant problems, among them the scarcity of rains. Despite these problems, the region is responsible for 55% of the Brazilian family agricultural production. Another issue of great importance in this region is related to the farm production methods and the consequent losses of the soil (CASTRO, 2012), as stated by Sousa (2007):

The lands are getting weaker and weaker because of the off-farm. The deforestation, the “drill,” the fires, the planting hill below, the monoculture and the use of poisons, cause erosion, spoil the land and decrease production, year by year, besides contributing to the

process of desertification of some areas in the region.

Procedures that reduce unexpected losses by water flow in the soil can benefit the penetration of water on the ground. Thus, it can be ensured the supply of water for the cultivation of grains, prevents erosion, and prevents flooding and the obstruction of rivers. At the same time are supplied the groundwater that nourishes the water flows. If during the rainy season, the terrain is not cultivated or graded there may be destruction and damage to the soil as well as the loss of water. Traditional methods of soil preparation, such as sowing in pits, are inefficient to repress the physical deterioration of the terrain (SANTOS; GRIEBELER; OLIVEIRA, 2010).

EMBRAPA researchers evaluated some soil tillage techniques. Among these, the best result obtained was the procedure known as barred grooves. The use of this method provides greater efficiency in the cultivation of grains and the structuring of the terrain (SANTIAGO; ROSSETTO, 2019).

In these agricultural precepts, soil biota is influenced a lot by the activities employed. For example, fertilization, crop rotation, irrigation, and land tillage systems and vegetation protection. However, this same biota manages processes such as mineralization, humidification, decomposition, immobilization and mobilization of micronutrients and macronutrients, aggregation and structuring of soil, nitrogen fixation and regulation of pests (COLOZZI FILHO, *et al.*, 2016).

According to Doran and Parkin (1994):

(...) soil quality is the capacity it has to exert its function within an ecosystem, namely: sustaining biological productivity; mitigate the effects of damage on the environment and promote animal and plant health.

In this field of activity, research is evolving and seeking to incorporate sustainability in agricultural production with the help of rural communities. Currently, even more plants that are resistant are developed in Brazilian environments and climates, in this case, the semiarid, in which some plantations may develop with low water consumption; seeds are produced for small cost systems in which fewer chemical fertilizers and pesticides are used for pest control. Included in this with higher productivity, the generated income also grows; these are tactics for conservation and application of our natural and social capital (SAMBUICHI *et al.*, 2012). For a better understanding of the terms used according to the Glossary of Culture (2007) “*The natural capital is constituted by the appropriation of natural resources that owns a region, and the share capital represents the degree of trust between the actors of a society, or positive attitudes towards civic behavior that contribute to the general*

well-being.”

In the hinterland, the agricultural economy is marked by pastoral activities, the creation of livestock and goats and sheep, and other species resistant to drought in the drier areas. This includes cotton and carnauba wax, and the production of maize, beans and manioc in the moistest regions and the sugarcane that is widely cultivated in the swamps of elevation (CARVALHO, 1993).

It is of utmost importance to give special attention to the vegetal extractivist field. Since the semiarid presents a great richness of plants resistant to the dry climate that could be exploited in the economic sphere. As for examples: oil producers (catolé, faveira, quince and oiticica); waxes (carnaúba); fibers (BROMELIACEAE); latex (pinion, maniçoba); fruit trees (imbuzeiro); medicinal trees (babosa, juazeiro) and general forage (some species of grass) (DUQUE, 2004).

The northeastern hinterlands present a massive amount of plants, but the knowledge about these is quite scarce. In this way, the preservation of the caatinga and the forest management, to keep these species in the environment, so that, subsequently, the population can use these plants, are means that need to be traversed so that it can reestablish this coverage vegetable. In this sense, government actions are essential (SANTOS; CAMERA, 2002).

Concerning reforestation, with exotic plants, further studies are needed to ensure more excellent safety when inserting them into the northeastern semiarid region. As an example, it is possible to cite the micro-region of the hinterland of Moxotó (formed by the municipalities of Pernambuco: Arcoverde, Betânia, Custodia, Ibibimirim, Inajá, Manari and Sertania), where reforestation activities with eucalyptus are already observed, with results harmful to the soil (CALDAS *et al.*, 2015).

The breeding crop is probably the most important of the options for the caatinga, primarily because it engages a region with a scarcity of protein. Successful actions in the municipality of Taperoá, district of Cariri in the state of Paraíba, have evidenced that the plantation of palm and the haymaking of forage resistant to drought, such as Buffel grass and urocloua, incorporated to the creation of a similarly resistant and double cattle ability (meat and dairy products), have allowed the survival of man in the region. Fish farming is another option that can be accomplished by using the capacity of existing dams (SOUZA *et al.*, 2019).

It is also of paramount importance to supply food for animals during periods of drought. Thus, it is an indispensable policy of supply of sugarcane bagasse, from sugar mills located in moist regions of the Northeast, to

be hydrolyzed and offered to animals (SOUZA *et al.*, 2019).

A more refined look is essential concerning the cultivation of grains in the boundaries of the semiarid. Since the climate of the region is severely unstable, making grain production a real “lottery.” In this way, the northeastern man is exposed to vexing situations of plowing the soil, planting the seeds and then seeing the production ruin itself with the merciless drought (SARTORI *et al.*, 2016).

After evaluating the individualities of the semiarid, it is possible to identify the causes and effects related to traditional agricultural production; thus, it is necessary to analyze the potential changes in this mode of production, so that there is a subsequent modification of the same. Here, it is crucial to cite how the agroecological sustainable output is given, because this way one can redefine the best methods to be used in planting, as well as in the cattle culture, among others (VIEIRA FILHO; SILVEIRA, 2012).

Agroecological practices seek to establish new formats of relationships between society and nature; since this is an environmentally appropriate, socially fair and economically viable practice. According to Santos and his collaborators (2014), this agriculture encompasses several production methods, amongst them:

Intercropping – a technological option for the small rural producer, since the second cultivation becomes a new source of income, strengthening the financial stability of the farmer, and influences to increase the productivity of the crop and decrease the number of pesticides;

Selective weeding – consists of selectively extracting herbs that have been maturing and which have been physiologically rebounded by cultivated plants;

Crop Consortium – Is an agricultural conservation technique that tends to better use in the long term of the soil. It focuses on planting different species close to each other;

Level Curve – it is the name used to indicate an imaginary line that groups two points with the same altitude. Through it is made the topographic maps, because, from the observation, the technician can decode their information through a three-dimensional view of the relief;

Dead coverage – it is one of the most beneficial practices that an owner can use to improve the health of their trees. Dead roofs are materials placed on the surface of the soil to maintain moisture and improve its conditions;

Organic fertilization – fertilizers obtained utilizing vegetable or animal origin, such as manure, flour, bagels, husks and remnants of plants, decomposed, or still in the

decomposition stage. These materials are decomposing and can be produced by man through composting;

Green fertilization (or green planting) – it is the name given to the practice of adding leguminous plants on the soil surface to enrich it nutritionally with nitrogen. The increase in the presence of nitrogen in the soil favors the improvement of plant biomass production;

Crop rotation – it consists of alternating, annually, plant species in the same agricultural area. The species chosen must have, at the same time, commercial and soil recovery purposes;

Natural insecticides – natural products derived from plants can be an alternative to pest control;

Reforestation – it is an environmental action that aims to repopulate areas that have had the vegetation removed by the forces of nature (fires, for example) or human activities (burned, wood exploration, expansion of agricultural areas, fires)

Agroecology has been gaining space in all Brazilian socioeconomic aspects, as well as in academic spaces, permeating the political-ideological discussions about sustainable agriculture (NODARI, 2015). As Fávero and Pacheco stress (2013):

Agroecology has been rooted in all Brazilian socioeconomic environments and contexts with a functional diversity of expressions, perceptions, and perspectives; it has increasingly permeated the scientific-academic circuits and, at the same time, is putting firmly into the political-ideological clash as a sustainable option of life in the field. It materializes, therefore, as a movement, carried out by a wide range of social organizations and networks; as a science, which is being constructed from conceptions, principles and methods differentiated from the Cartesian-positivist precepts; and as a practice experienced, transmitted, innovated and (re)invented by farmers and agriculture in different conditions and realities throughout the Brazilian territory using this denomination or not.

Because of the above, we perceive the evolution of agroecology over the years in Brazil, especially in the semiarid region of the Northeast. Interestingly, agroecology has been expanding in several areas, such as socioeconomic and academic spaces. What is new and particularly relevant to this study are the agroecological techniques used in the territory of Exu-PE, our question is whether these techniques are being worked in appropriate ways, whether there has been changing or just an exchange of methods of production.

V. AGROECOLOGY IN THE MUNICIPALITY OF EXU-PE

The Araripe region, in which the municipality of Exu is located, concentrates 40% of the world gypsum reserves and is therefore characterized by the exploration of the mineral in the so-called gypsum-polo. The mineral reserves are one of the significant differentials of the region, is estimated at 1.2 billion tons. Gypsum extraction represents 95% of the national gypsum production, which enabled the formation of an industrial park in the region, generating about 12,000 direct and 60,000 indirect jobs (IBGE, 2010).

Besides the extraction of gypsum, which is the main activity, there is the subsistence culture in the upland areas; the large livestock and the diversified agriculture in the Chapada (plateau) do Araripe (SILVA *et al.*, 2006).

Exu is part of the Araripe development region, located in the hinterlands of the state of Pernambuco mesoregion. It represents 18.8% of the state territory with 18,576.9 sq.km and covers the municipalities of Araripina, Bodocó, Cedro, Granito, Ipubi, Moreilândia, Ouricuri, Parnamirim, Salgueiro, Santa Cruz, Santa Filomena, Serrita, Trindade and Verdejante. The municipality of Exu is mainly inserted in the Geoenvironmental unit of the Maciços and Serra Baixas, with altitudes between 300 and 800 meters. To the north, a portion is embedded in the Geoenvironmental group of the high plateaus (IBGE, 2010).

Exu is a municipality in the state of Pernambuco, in the Brazilian outback. Administratively, the city is composed of the headquarters district and the villages of Tabocas, Timorante, Viração, and Zé Gomes. Located on the BR-122, the height of the Serra do Araripe is the last city in the border between the states of Pernambuco and Ceará. With its 109 years, it has been growing gradually. The region where the municipality is located was initially inhabited by the Ançus Indians, from the Cariris' trunk. The area was occupied by cattle farms in the early 18th Century, with Leonel de Alencar Rego and subsequently his son, Joaquim Pereira de Alencar. After the occupation, Jesuit missions lived in the region, where they built the chapel of Bom Jesus dos Aflitos (IBGE, 2010).

The municipality was installed on June 7, 1885, gaining autonomy on July 9, 1893, due to Law # 52, of August 3, 1892. The first mayor was Manoel da Silva Parente. The municipality was suppressed in 1895 and restored 1907, with the designation of Novo Exu. By state Decree-Law # 235, of December 9, 1938, the city of Novo Exu became the denominate Exu (IBGE, 2010).

The city is located in the polygon of drought; its

relief presents flat and rugged terrains influenced by the Chapada (plateau) do Araripe, with highlands, flat and descending the mountains, are low lands, fertile land, and several springs at the foot of the hill. The vegetation is predominantly of deciduous forest and hypoxerophyll caatinga. The municipality also has the plant of the savanna at the foot of the plateau, with species such as aroeira, braúna, sabiá, plum, pequi, sucupira, angico, white and red amburana, cedar, angico, eucalyptus, and the barriguda, almost extinct (SILVA *et al.*, 2006).

Yres explains (2014):

Among the vegetation types in the semiarid region is the Cerrado, whose flora represents the continuity of the flora present in Central Brazil. The Cerrado has two distinct seasons: dry winter and rainy summer. With tropical savannah soil, nutrient deficient and rich in iron and aluminum, it houses dry-looking plants, between sparse shrubs and grasses, and Cerradão, a denser type of vegetation, of forest formation, formed by low and twisted trees highlighted in the middle of the greens covering the top of the plateaus.

The main animal species of the region are the preá, tatupeba, opossum, sagui, vulture, owl, hawk, fox, as well as a large variety of birds and reptiles. The municipality of Exu is located in the watershed of the Brígida River. Its main tributaries are the streams of Brígida, Carnaúba or Carrancudo, Queimada Grande, Tabuleiro, Cantarino, do Ouro, California, Manicoba, Zé Gomes, Estrada, Paus Grandes, Tabocas, Mocambo, São Joaquim, and Tigre, all of which are intermittent. It also has the lagoons of Caraíba, de Dentro, Cascavel, Caracol, Grande, and Marrecas (SILVA *et al.*, 2006).

The city of Exu has the predominant economic activity of agriculture. Cattle and swineherds are in more significant numbers. The main cultivated agricultural products are beans, tobacco, corn, cassava, coffee, and castor bean. The agrarian practice in Exu gives itself, in its vast majority, in a traditional way; from soil preparation to harvesting. The soil is prepared by burning after the first rains expect the process for planting the seeds. In this period, farmers expect the rainy season to thrive for the plantation to be harvested; the harvest is done manually.

In the municipality, there are already some communities that practice agroecology. Among them are the Baixio do Meio, the Serra do Ingá and Serra da Refrigerera with a production, mainly of fruit and vegetable trees; the most prominent community is ruled by the Lermen family, in the Serra dos Paus Doíás site.

VI INFLUENCE OF CIVIL SOCIETY ORGANIZATIONS IN THE IMPLEMENTATION OF AGROECOLOGICAL SYSTEMS IN EXU-PE

The NGO Caatinga (Center for Advisory and Support to Workers and Alternate Non-Governmental Organizations) has been working for more than 25 years with agricultural families in rural communities in the territory of Sertão do Araripe, in the State of Pernambuco.

Indirectly, its performance extends to the entire semiarid through its participation in the Network of Technical Assistance and Rural Extension of the Northeast (Ater-NE network), the Articulation of the Brazilian Semiarid (ASA) and the National Articulation of Agroecology (ANA).

About the NGO, Carvalho argues that:

Since its inception, the entity has maintained its firm purpose to support the construction of knowledge, technologies, and practices of agroecological basis together with agricultural families and their organizations, as a way to strengthen the capacity of rural populations for dignified and sustainable coexistence with semiaridity. (2007)

In 2006, the CAATINGA acquired the position of national Focal Point of Civil Society of the United Nations Convention on Combating Desertification (UNCCD), a political representation attributed and backed by ASA.

Several families and rural communities have changed their lives through the most harmonious relationships with nature. His experiences prove that environmental degradation is not an irreversible result of family farming in the semiarid. Accordingly, Carvalho (2007) states that: People do not degrade because they want to. On the contrary: many public policies and market agents continue to be encouraged to adopt degrading practices that put them in a situation of a significant vulnerability in the context of drought risk. Besides, most families have not yet had the opportunity to develop innovative initiatives based on the principle of coexistence with the semiarid in their properties.

The experiments developed in the Araripe region indicate that there is a broad “sensitivity and receptivity” to the new management approaches based on the principles of agroecology. However, many limitations hinder the generalization of these techniques. The local novelty is a necessary condition for these techniques to progress and adapt to the particularities of each family and community. It requires “mobilization and social organization” to create adequate spaces for the cultivation and socialization of agroecological knowledge. This

mobilization is essential to influence public managers and public policy formulators. Thus, it is indispensable that the struggle for the stabilization of sustainable development is constant, building knowledge in a dialogical way and committed to a “fair society, economically viable, environmentally balanced and fraternal” (TEIXEIRA PIRES, 2017).

By extending the positive influences of the experiments that already exist in coexistence with the semiarid, it can be ensured that the environmentally sustainable and socially inclusive development is probably in the region. However, Carvalho (2007) clarifies that:

(...) it is necessary to involve more people, organizations, and networks of civil society to maintain and broaden the dynamics of the construction of agroecological knowledge, mobilizing and gathering forces to achieve the stable and concrete changes in the policies of State and finally in the rural development model in the region.

The caatinga has offered its support in this procedure, acting as an organization encouraging the building of new knowledge alongside communities, agricultural families, networks and articulations, as well as encouraging the spaces for the elaboration of public policies with the help of social organizations and movements (SANTOS; SILVA, 2015; SANTOS; SILVA, 2016; SOARES et al, 2018;.

The Center for Enabling and Supporting the Small Farmer of Araripe (CHAPADA in Portuguese), was created in April 1994, by a group of farmers/the family and technicians of the municipality of Araripina, Sertão de Pernambuco.

The work of CHAPADA is developed in ten municipalities of the Araripe region in the state of Pernambuco, in addition to six towns in the area of the middle São Francisco in the state. The actions of the entity are geared towards farmers and family farms organized in associations, cooperatives, unions, and forums. This work is supported by the Association of the One Million Cisterns Program (APIMC); Ministry of Agrarian Development (MDA); Secretariat of Family Agriculture (SAF); Secretariat for Territorial Development (SDT); Project Dom Helder Câmara (PDHC); International Service/European Union; Secretariat of Agriculture and Agrarian Reform (SARA) and Pro Rural.

The activities developed to allow the recovery of soils and native vegetation, as well as enable the implantation of agroecological systems, and the development of the production chains of manioc-cultivation, horticulture, beekeeping, and caprino-ovino-

culture. From this, the institution implements actions to create a good water infrastructure in rural communities, especially concerning access to water for human consumption, domestic, water supply for animals and other productive purposes.

It is in the perspective of guaranteeing food security and the generation of work and income for agricultural families, which gives access to markets for commercialization of agroecological products *in natura* as well as processed ones. The CHAPADA promotes educational actions that strengthen the organizations represented by farmers/family members, intending to facilitate access to public resources, and in defense of social rights, contributing to the realization of citizenship.

The institution discusses and considers in all its projects, gender relations from the perspective of differences and inequalities existing between men and women. The idea is to build an alternative path to promote equal opportunities. Currently, in all its activities, the CHAPADA has privileged and stimulated the presence of young people.

The mission of the institution as mentioned earlier is to strengthen the socioeconomic, political and cultural development of family farming, through the recovery and preservation of the environment, through agroecology and the realization of citizenship in the semi-arid. The objectives of the NGO are:

Provide professional training, advice, and technical assistance to farmers/family members, enabling food security, generation of employment and income with environmental and social sustainability of the estates.

Offer professional training, advice and technical assistance to the processing units of agricultural products, seeking the quality of processed products;

Offer professional and business training to farmers/family members, stimulating the associative organization ensuring access to markets. In particular, concerning the organization of agroecological fairs and access to government marketing programs;

Develop actions to create a water infrastructure in rural properties and communities;

Develop measures that facilitate the access of farmers to public policies for the development of family farming and the improvement of quality of life in rural communities;

Promote educational activities that strengthen associative political articulation, in a way that assures the conquest of social rights and citizenship;

Develop actions that contribute to gender equality and the promotion of youth rights.

The NGO participates in the following institutional

spaces: articulation in the Brazilian semi-arid (ASA Brazil); Sustainable Development Council of Pernambuco (CDSPE); Araripina Rural Development Council (CDRA); State Environmental Council (CONSEMA); Municipal Council for Social Action of Araripina; Municipal Council for Rural Development of Araripina (CMDR); Municipal Council for Sustainable Development of Ipubi (CONDESI); Araripina Municipal Environmental Council (CONDEMA); Municipal Council for Food Security and Sustainable Nutrition of Araripina (COMSEA); Forum of the Goat and Sheep Breeding in the Araripe region; Manioc-Culture Forum of the area of Araripe in the state of Pernambuco (FOMAPE); Araripe Women's Forum; Territorial Forum of Araripe (FOTEAR); Pact of beekeeping of the Sertão do Araripe (Forum Pasa).

The CHAPADA is affiliated with the Brazilian Association of Non-Governmental Organizations (Abong). The NGO directs its action, from four strategic axes that enable the fulfillment of its mission. They are:

Agroecology and coexistence with semi-arid – guiding activities aimed at the implementation and development of agroforestry systems, organic horticulture, honey production, goat and sheep breeding, poultry farming, fish farming, enlargement and adequate management of hydric infrastructure of rural properties and communities;

Entrepreneurship in family farming and access to markets – agriculturists and family farmers qualified in property planning, cost calculations and sales price, and rural entrepreneurship. Technical monitoring in the implementation and development of agroecological municipal fairs, local fairs of goats and sheep and sales to commercial establishments;

Youth Protagonism – stimulating actions that contribute to the professional qualification and insertion of young people in agroecological farming activities, as a fundamental strategy for the generation of income and fixation of young people in rural areas. Youth Protagonism is stimulated from community activities and local development;

Communication and institutional strengthening – expansion of social visibility through institutional actions, in the perspective of strengthening and disseminating the results achieved with the agricultural families and their organizations involved in the work of Entity.

The CHAPADA strengthens the socioeconomic, political and cultural development of family farming, through agroecology and the realization of citizenship in the Brazilian semi-arid. The city of Exu is part of the organization's territory and has significant results in the

field of sustainable family farming and coexistence with the semi-arid.

VII CONCLUSION

The primary purpose of this work was to describe the agroecology, its methods and utilization, verifying the implantation of the same in the municipality of Exu-PE, more precisely in the Chapada (plateau) do Araripe in the Serra (Mountain) dos Paus Doíás. Agroecology is providing scientific and methodological bases for the production of various types of sustainable agriculture, having as one of its main objectives the need for food production in larger quantities and high quality biologically for the whole of society.

From the study, we also understand that agroecology brings with it its characteristics enabling a more precise understanding regarding the life of the family producer who inhabits the municipality of Exu-PE. The results of this work help to conceive the importance of agroecology, highlighting its fundamental social role of the inequality of the countryside and cities, this sector must be regarded as a strong element of wealth generation for the economy, not only for the agricultural sector or even for a specific region, but also for the whole country. Thus, we believe that agroecology fulfills a significant social, cultural, and economic role, also guaranteeing food safety for consumers of food produced under this method.

REFERENCES

- [1] AB'SABER, A. (2003). Os Domínios de natureza no Brasil: Potencialidades Paisagísticas, São Paulo: Ateliê Editorial,
- [2] ALMEIDA, D. L. (1998). Sistema Integrado de Produção Agroecológica ("Fazendinha Agroecológica km 47"). In: ENCONTRO NACIONAL SOBRE PRODUÇÃO ORGÂNICA DE HORTALIÇAS. 1998, Vitória. Anais... Vitória: EMCAPA.
- [3] AQUINO, A. M.; ASSIS, R. L. (OrgS.) (2005). Agroecologia: princípios e técnicas para uma agricultura orgânica sustentável – Brasília, DF: Embrapa Informação Tecnológica.
- [4] ARAÚJO, Q. R. (org.). (2002). 500 anos de uso do solo no Brasil. Ilhéus, Ba: Editus.
- [5] ASSIS, R. L. (2006). Desenvolvimento rural sustentável no Brasil: perspectivas a partir da integração de ações públicas e privadas com base na agroecologia. Econ. Apl., Ribeirão Preto, v. 10, n. 1, p. 75-89. Available from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1413-80502006000100005&lng=en&nrm=iso. Access on 20 may 2019. <http://dx.doi.org/10.1590/S1413-80502006000100005>.
- [6] ASSIS, R. L. (2005). Agricultura orgânica e agroecologia: questões conceituais e processo de conversão. Seropédica: Embrapa Agrobiologia. (Embrapa Agrobiologia. Documentos, 196)
- [7] ASSUNÇÃO, M.; LIVINGSTONE, I. (1993). Desenvolvimento inadequado: construção de açudes e secas no sertão do Nordeste. Bras. Beon. Rio de Janeiro, v. 47, n. 3, p. 425-48.
- [8] AZEVEDO, E.; PELICIONI, M. C. F. (2011). Promoção da Saúde, Sustentabilidade e Agroecologia: uma discussão intersetorial. Saude soc., São Paulo , v. 20, n. 3, p. 715-729. Available from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0104-12902011000300016&lng=en&nrm=iso. Access on 20 may 2019. <http://dx.doi.org/10.1590/S0104-12902011000300016>.
- [9] BRASILEIRO, R. S. (2009). Agricultura de base agroecológica como viabilidade para o desenvolvimento rural sustentável: o processo de organização de agricultores familiares para o desenvolvimento de cultivos dentro dos princípios agroecológicos. Revista de Geografia. Recife: UFPE – DCG/NAPA, v. 26, n. 3.
- [10] CALDAS, R. M. S.; MACHADO, J. ANDRADE, J. S. C. O.; WANDERLEY, R. A. (2015). Processing of Melon crops for beekeeping in the backwoods of Moxotó represented by Digital Terrain Model. Revista GEAMA, Recife, v. 1, n.1.
- [11] CAPORAL, F. R. (2007). Extensão Rural e Agroecologia: temas sobre um novo desenvolvimento rural, necessário e possível. Brasília: MDA.
- [12] CAPORAL, F. R. COSTABEBER, J. A. (2004). Agroecologia: alguns conceitos e princípios. Brasília: MDA/SAF/DATER-IICA.
- [13] CARVALHO, P. P. A (2012). convivência com o semiárido como estratégia para o combate à desertificação: Uma experiência no Sertão do Araripe. Agriculturas | v. 9 - n. 3 | dezembro de Available at: <http://www.agriculturesnetwork.org/magazines/brazil/desertificacao/experiencia-sertao-doararipe#sthash.7qUoQxmi.dpuf>. Access on April 24th, 2019.
- [14] CASCÃO, R. *et al.*, (coords). (2007). Glossário de Cultura. Serviço Social da Indústria. Departamento Nacional. SESI. DN. Brasília: SESI/DN. Available at: http://www.sesipr.org.br/uploadAddress/Glossario_de_Cultural130431.pdf Access on April 15, 2019.
- [15] CASTRO, C. N. (2012). A agricultura no Nordeste brasileiro: oportunidades e limitações ao desenvolvimento. Texto para discussão. Instituto de Pesquisa Econômica Aplicada. Brasília: Rio de Janeiro: Ipea.
- [16] COLOZZI FILHO, A. *et al.* (2016). Reunião Brasileira de Manejo e Conservação do Solo e da Água (20: 2016: Foz do Iguaçu, PR) Anais da XX Reunião Brasileira de Manejo e Conservação do Solo e da Água [electronic book]. Curitiba: SBCS/ NEPAR; Londrina: IAPAR.
- [17] CURADO, F. F. *et al.* (2014). Sistematização de Experiências Agroecológicas no Território Semiárido Nordeste II, Bahia. Cadernos de Ciência & Tecnologia, Brasília, v. 31, n. 2, p. 349-380.
- [18] D'ÁVILA, D. (2004). Cuidado sistematizado ao paciente

- com monitorização da pressão intracraniana: Uma Proposta. Palhoça: Monografia de especialização de Enfermagem em Emergência e Terapia Intensiva, Universidade do Sul de Santa Catarina.
- [19] DE DEUS, R. M.; BAKONYI, S. M. C. (2012). O impacto da agricultura sobre o meio ambiente. *Rev. Elet. em Gestão, Educação e Tecnologia Ambiental* v. 7, nº 7, p. 1306-1315.
- [20] DORAN, J. W; PARKIN, T.B. (1994). Defining and assessing soil quality. In. Doran, J. W. *et al.* (Eds.) *Defining soil quality for a sustainable environment*. Madison. ASA/SSSA.
- [21] DUQUE, J. G. O (2004). *Nordeste e as lavouras xerófilas* 4a ed. Fortaleza: Banco do Nordeste do Brasil.
- [22] FÁVERO, C.; PACHECO, M. E. L. (2013). *Agroecologia: princípios e reflexões conceituais: Seguindo em frente na construção social da agroecologia*. GOMES, J. C. C.; ASSIS, W. S. (Org.); Brasília, DF: Embrapa.
- [23] FERREIRA, A. B. H. (2001). *Minidicionário Aurélio da Língua Portuguesa*. 4ed. rev. ampliada. Rio de Janeiro: Nova Fronteira.
- [24] FINATTO, R. A.; SALAMONI, G. (2008). *Agricultura familiar e agroecologia: perfil da produção de base agroecológica do município de Pelotas/RS*. *Sociedade & Natureza, Uberlândia*, v. 20, n. 2, p. 199-217.
- [25] FUNDAÇÃO BANCO DO BRASIL (2009). *Manual de Capacitação da Tecnologia Social PAIS Produção Agroecológica Integrada e Sustentável*. Brasília. Available at: https://www.fbb.org.br/data/files/18/D6/A9/1E/8266A31009818793BD983EA8/PAIS_Pr_tic_a%20da%20Agroecologia.pdf. Access on May 08, 2019.
- [26] HERNANDEZ, S. R. (2012). *Metodología científica*. México.
- [27] IBGE. «Área territorial oficial». Resolução da Presidência do IBGE de nº 5 (R.PR-5/02). «Estimativa da população 2015 » População estimada » Comparação entre os municípios: Pernambuco». *Estimativa Populacional - 2015*. Instituto Brasileiro de Geografia e Estatística (IBGE). Agosto de 2015.
- [28] MANZATTO, C. V., FREITAS JUNIOR, E.; PERES, J. R. R. (ed.). (2002). *Uso agrícola dos solos brasileiros*. Rio de Janeiro: Embrapa Solos.
- [29] MAZZOLENI, E. M.; NOGUEIRA, J. M. (2006). *Agricultura orgânica: características básicas do seu produtor*. *Rev. Econ. Sociol. Rural, Brasília*, v. 44, n. 2, p. 263-293. Available from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-20032006000200006&lng=en&nrm=iso. Access on May 20, 2019. <http://dx.doi.org/10.1590/S0103-20032006000200006>.
- [30] MONASTERIO, L. M.; NERI, M. C.; SOARES, S. S. D. (2014). *Brasil em desenvolvimento 2014: estado, planejamento e políticas públicas*. Brasília: Ipea.
- [31] NODARI, R. O.; GUERRA, M. P. (2015). *A agroecologia: estratégias de pesquisa e valores*. *Estud. av.*, São Paulo, v. 29, n. 83, p. 183-207. Available from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-40142015000100183&lng=en&nrm=iso. Access on May 20, 2019. <http://dx.doi.org/10.1590/S0103-40142015000100010>.
- [32] SAMBUICHI, R. R.; OLIVEIRA, M. A. C.; SILVA, A. P. M.; LUEDEMANN, G. A. (2012). *Sustentabilidade ambiental da agropecuária brasileira: impactos, políticas públicas e desafios*. Texto para discussão. Instituto de Pesquisa Econômica Aplicada. Brasília: Rio de Janeiro: Ipea.
- [33] SANTIAGO, A. D. ROSSETTO, R. (2019). *Árvore do conhecimento: Cana-de-Açúcar*. Disponível em: https://www.agencia.cnptia.embrapa.br/gestor/cana-deacucar/arvore/CONTAG01_84_22122006154841.html. Access May 20, 2019.
- [34] SANTOS, C. F. *et al.* (2014). *A agroecologia como perspectiva de sustentabilidade na agricultura familiar*. *Ambiente & Sociedade, São Paulo*, v. 17, n. 2, p. 33-52. Available from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1414-753X2014000200004&lng=en&nrm=iso. Access on 20 may 2019. <http://dx.doi.org/10.1590/S1414-753X2014000200004>.
- [35] SANTOS, G. G.; GRIEBELER, N. P.; OLIVEIRA, L. F. C. (2010). *Chuvas intensas relacionadas à erosão hídrica*. *Revista Brasileira de Engenharia Agrícola e Ambiental* v. 4, n. 2, p.115–123.
- [36] SANTOS, T. C. C.; CÂMERA, J. B. D. (2002). *Programa das Nações Unidas para o Meio Ambiente*.
- [37] SANTOS, C. A. B.; SILVA, A. P. M. (2015). *Extratos vegetais de plantas daninhas contra o pulgão aphid craccivora Koch 1854, no feijão vigna unguiculata (L.) walp.* *Revista Ibero-Americana de Ciências Ambientais, Aquidabã*, v.6, n.2, p.69-75. DOI: <http://dx.doi.org/10.6008/SPC2179-6858.2015.002.0005>
- [38] SANTOS, C. A. B.; SILVA, A. P. M. (2016). *Viabilidade do uso de inseticidas botânicos extraídos de plantas exóticas*. *Educação Ambiental em Ação*. Número 54, Ano XIV. Available on: <http://www.revistaecologia.org/artigo.php?idartigo=2241>. Access in: 23 march 2019.
- [39] SARTORI, G. M. S. *et al.* (2016). *Sistemas de preparo do solo e de semeadura no rendimento de grãos de soja em área de várzea*. *Cienc. Rural, Santa Maria*, v. 46, n. 3, p. 492-498. Disponível em http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-84782016000300492&lng=pt&nrm=iso. Access on May 20, 2019. Epub 30-Nov-2015. <http://dx.doi.org/10.1590/0103-8478cr20150676>.
- [40] SILVA, R. M. A (2007). *Entre o combate à seca e a convivência com o Semi-Árido: políticas públicas e transição paradigmática*. *Revista Econômica do Nordeste, Fortaleza*, v. 38, n. 3, p. 466-485.
- [41] SILVA, R. M. A. (2003). *Entre dois paradigmas: combate à seca e convivência com o semiárido*. *Sociedade e Estado, Brasília*, v. 18, n. 1/2, p. 339-360.

- [42] SILVA, J. B.; DANTAS, E. W. C.; ZANELLA, M. E.; MEIRELES, A. J. A. (orgs.). (2006). Litoral e Sertão, natureza e sociedade no nordeste brasileiro. Fortaleza: Expressão Gráfica.
- [43] SILVA, M. A. M.; FRUTUOSO, M. N. M. A.; RODRIGUES, S. S. F. B.; NOGUEIRA, R. J. M. C. (2016). Fatores socioambientais influenciados pela seca na conservação da caatinga. HOLOS, Ano 32, v. 4, p. 245-257.
- [44] SILVEIRA, L.; PETERSEN, P.; SABOURIN, E. (Org.). (2002). Agricultura familiar e agroecologia no Semi-Árido: avanços a partir do Agreste da Paraíba. Rio de Janeiro: ASPTA.
- [45] SOARES, T. N. A. et al. (2018). Insecticide Potential of Botanic Extracts Obtained from the Flora of the Brazilian North East Region. European Scientific Journal, v.14, n.18, p. 1-13. Doi: 10.19044/esj.2018.v14n18p1 URL:<http://dx.doi.org/10.19044/esj.2018.v14n18p1>. Disponível em: <http://ejournal.org/index.php/esj/article/view/10953>. Acesso em: 01 de junho de 2019.
- [46] SOUSA, J. E.; SILVA, A. F. (2007). Agricultura agroflorestal ou agrofloresta. Centro Sabiá. Recife-PE.
- [47] SOUZA, J. T. A.; NASCIMENTO, M. G. R.; FIGUEREDO, J. P.; NÁPOLES, F. A. M.; ANDRADE, F. H. A. (2019). Caracterização técnico-produtiva do sistema de cultivo de palma forrageira no Cariri paraibano. Revista de Agricultura Neotropical, v. 6, n. 2, p. 64-71.
- [48] TEIXEIRA, C. T. M.; PIRES, M. L. L. S. (2017). Análise da Relação Entre Produção Agroecológica, Resiliência e Reprodução Social da Agricultura Familiar no Sertão do Araripe. Rev. Econ. Sociol. Rural, Brasília, v. 55, n. 1, p. 47-64. Available from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-20032017000100047&lng=en&nrm=iso. Access on 20 May 2019. <http://dx.doi.org/10.1590/1234-56781806-94790550103>.
- [49] TROLEIS, A. L.; SANTOS, A. C. V. (2009). Estudos do semiárido. Natal: EDUFRN 2011 BRASIL. Departamento Nacional de Infraestrutura de Transportes. Diretoria Executiva. Instituto de Pesquisas Rodoviárias. Manual de vegetação rodoviária. Rio de Janeiro.
- [50] VIEIRA FILHO, J. E. R.; SILVEIRA, J. M. F. J. (2012). Mudança tecnológica na agricultura: uma revisão crítica da literatura e o papel das economias de aprendizado. Rev. Econ. Sociol. Rural, Brasília, v.50, n. 4, p. 721-742. Available from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-20032012000400008&lng=en&nrm=iso. Access on 20 May 2019. <http://dx.doi.org/10.1590/S0103-20032012000400008>.
- [51] YRES, J. A. (2014). Biodiversidade e a Vegetação do Semiárido. Semiárido Nordestino. III Encontro Nordestino de Arborização Urbana. Available at: <https://janayresespgeo.wordpress.com/2014/07/02/a-biodiversidade-e-a-vegetacao-dosemiarido/>. Access on May 07, 2019.

Approach of Passive Filters using NSGA II in industrial installations: Part II

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Abstract— The optimization of passive filters in industrial systems has been presented by different computational methods. The objective of this paper is to develop a computational algorithm with NSGA II to select the configuration and design parameters of a set of passive filters for industrial installations. As a methodology, the optimization problem was addressed using three independent objective functions of innovative character for compensation of harmonics through passive filters as a multiobjective problem. The results were the computational solution to this problem that determines a set of Pareto optimal solutions (Frontier). In addition, the Computational tool has several new features such as: calculates the parameters that characterize the filters, but also selects the type of configuration and the number of branches of the filter in each candidate bar according to set of pre-established configurations according to PRODIST-M8 (Brazilian Standard) and IEEE 519-2014. Also determine solutions with good power quality indicators (THD, TDD and NPV) for several characteristic and non-characteristic scenarios of the system that allow to represent: daily variations of the load, and variations of system parameters and filters. It evaluates the cost of energy bills in an industrial power grid that has different operating conditions (characteristic scenarios) and evaluates the economic effect of harmonic filters as reactive power compensators.

Keywords—Quality Power, NSGA II, Passive Filters, multiobjective optimization.

I. INTRODUCTION

Modern electrical systems contain a large amount of contaminant sources or harmonic producers, where the nonlinear loads used in industry, commercial and residential installations stand out [1][2][3].

As fontes contaminantes de média e alta potência geralmente se concentram nos sistemas elétricos industriais. Entre estas se incluem conversores estáticos de potência e fimos de arco elétrico [4][5][6][7].

In commercial and residential installations, a large number of nonlinear loads of small power are employed, which due to their large number can not be neglected as a source of distortion. This is the case of home and office equipment, discharge lamps, among others.

The harmonics injected into the electrical system by nonlinear loads produce effects on the electrical power systems themselves and on the electrical loads connected to them, as well as on communications systems. [8][9][10][11].

All the effects of harmonics in power systems are harmful and among them we can mention [12][13][14][15]:

- 1) The possible existence of series and parallel resonances, which contribute to the amplification of harmonics and their effects;
- 2) Reduction of system efficiency, increasing losses in power generation, transmission and distribution systems;
- 3) The premature aging of the insulation of the components of the electrical network and, consequently, reduction of its useful life.
- 4) The malfunction of the system or any of its components.

One of the most damaging phenomena associated with the presence of harmonics is the possibility of **resonance** occurring in the electric circuit. Like most elements in power systems such as transformers, rotary machines, etc. have the inductive character, the presence of capacitor banks to compensate for the power factor or the own capacitive effect of the power lines can interact with the inductive elements of

the circuit so that at certain frequencies are equal to the equivalent inductive and capacitive reactances causing a condition of resonance in which high values of voltage and current, which affect the correct functioning of the system and can cause equipment failure [16][17][18].

Harmonic filters are active or passive devices, whose mission is to avoid harmonic circulation by the electrical power system to prevent the occurrence of harmful resonances and avoid other undesirable effects that may occur [19][20][21].

Although active filters have better performance characteristics than passive, the latter are still more used

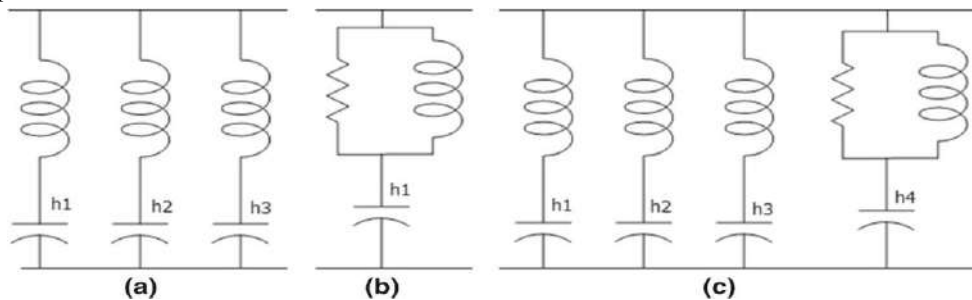


Fig.1: Predefined configurations of the filters.

Source: [23].

2.1 FILTER TYPES

A low-pass (LP) filter passes the low-frequency components and suppresses the high-frequency components. Their loss characteristic is given by

$$A(\omega) = 0, 0 \leq \omega < \omega_c \quad (1)$$

$$= \infty, \omega_c < \omega < \infty$$

The frequency from 0 to ω_c is the passband and from ω_c to ∞ is stopband. The boundary between passband and stopband $= \omega_c$ is the cutoff frequency. However, there cannot be a sudden transition from passband to stopband. Practically, passband loss is not zero, and the stopband loss is not infinite. There is a gradual transition between passband and stopband. Then, for the LP filter, the loss characteristic is [22]:

$$A(\omega) \leq A_p, 0 \leq \omega \leq \omega_p \quad (2)$$

$$\geq A_s, \omega_s \leq \omega \leq \infty$$

A high-pass filter acts in the reverse manner, suppresses the low frequency, and passes the high frequency. For an ideal filter

$$A(\omega) = \infty, 0 \leq \omega < \omega_c \quad (3)$$

$$= 0, \omega_c < \omega < \infty$$

For a practical filter, the loss characteristic is

$$A(\omega) \geq A_s, 0 \leq \omega \leq \omega_s \quad (4)$$

$$\leq A_p, \omega_p \leq \omega \leq \infty$$

than the former. Figure 1 shows the pre-definition of filters types according to [29].

II. PASSIVE FILTERS

Passive filters use passive components, such as inductors, capacitors, and resistors. These cannot increase the signal energy; the frequency range for harmonic filters is limited to approximately 3000 Hz. It is common to characterize the frequency-selective filters with respect to their passbands [22].

The bandpass filter passes frequencies within a certain band and blocks the low and high frequencies. Ideally,

$$A(\omega) = \infty, 0 \leq \omega < \omega_{c1}$$

$$= 0, \omega_{c1} < \omega < \omega_{c2} \quad (5)$$

$$= \infty, \omega_{c2} \leq \omega < \infty$$

For a practical filter, the loss characteristic is

$$A(\omega) \geq A_s, 0 \leq \omega \leq \omega_{s1}$$

$$\leq A_p, \omega_{p1} \leq \omega \leq \omega_{p2} \quad (6)$$

$$\geq A_s, \omega_{s2} \leq \omega \leq \infty$$

The loss function referred earlier can be determined as follows: A filter represented by voltage transfer function:

$$\frac{V_o(s)}{V_i(s)} = H(s) = \frac{N(s)}{D(s)} \quad (7)$$

where $V_i(s)$ and $V_o(s)$ are the input and output voltages and $N(s)$ and $D(s)$ are polynomials in s .

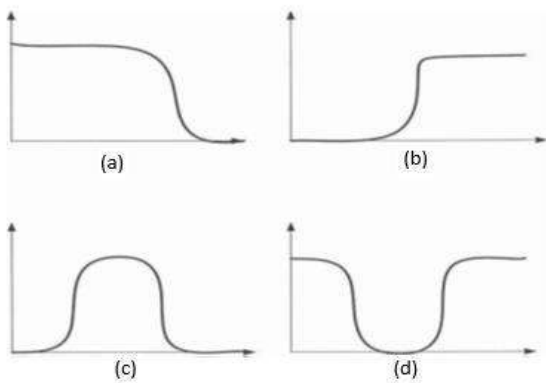


Fig.2: Frequency response of low-pass (a), high-pass (b), bandpass (c), and stopband (d) (notch) filters.

Source: [22].

The loss or attenuation is in decibels:

$$A(\omega) = 20 \log \left| \frac{V_i(j\omega)}{V_o(j\omega)} \right| = 20 \log \frac{1}{|H(j\omega)|} \quad (8)$$

The filters for harmonic mitigation are generally of shunt type to offer a low-impedance path to a certain harmonic or harmonics so that these are bypassed into the filter and their flow is minimized into the system, as discussed in the following section [22][24][25].

These may use resonance in the filter components to offer minimum impedance to a particular harmonic or a band of harmonics. This does not mean that we do not use series filters, that is, filters connected in series with the converter to impede the flow of a certain harmonic [26].

2.3 LOCATION OF HARMONIC FILTERS

Passive filters at suitable locations, preferably close to the source of harmonic generation, can be provided so that much of the harmonic currents are trapped at the source and the harmonics propagated to the point of common coupling (PCC) are reduced. Active filters, hybrid combination of active and passive filters, and phase multiplication to reduce harmonic emission. By reduction of harmonics at the source, the electrical equipment need not be oversized, losses are minimized, voltage distortions are reduced, the filters can be [22]. Conversely, when filters are located away from the harmonic producing loads, the harmonics must flow to the filter through system impedances with the resultant derating of electrical equipment. Yet, it may not be practical or economical to provide filters at each source of harmonic emission.

The key considerations are the following:

- Harmonic limitations at PCC must meet IEEE 519 requirements, but it is desirable to limit harmonic distortions throughout the power systems [22].

- Reactive power compensation may be simultaneously required.
- Normal and contingency conditions of the plant operation, along with ambient harmonics, must be considered.
- Normal and contingency filter conditions must be considered.
- Harmonic emission must be estimated correctly under various operating conditions.
- System interaction with harmonic emissions must be considered.
- A three-phase modeling may be necessary where large unbalances exist.

II.4 SINGLE-TUNED FILTERS

The single-tuned (ST) filters are efficient filters and will bypass a certain harmonic to which these are tuned. These are most widely used filters in all applications of harmonic mitigation. However, care is required in their design, so that the components are not overloaded, and overvoltages due to their applications are controlled. Many times a group of ST filters are applied, each tuned to a specific frequency [22].

The operation of an ST shunt filter is explained with reference to Fig. 3. (Any other type of filter connected in the shunt can be termed a shunt filter.) Figure (a) shows a system configuration with nonlinear load, and Fig. 3(b) shows the equivalent circuit. Harmonic current injected from the source through impedance Z_c divides into filter and system equivalent impedance Z_{eq} . This system impedance can be found by circuit reduction – this is in fact the short-circuit equivalent impedance at bus 1.

The current I_s divides into three parallel paths: the current at PCC is the current flowing through utility source, and utility transformer is series:

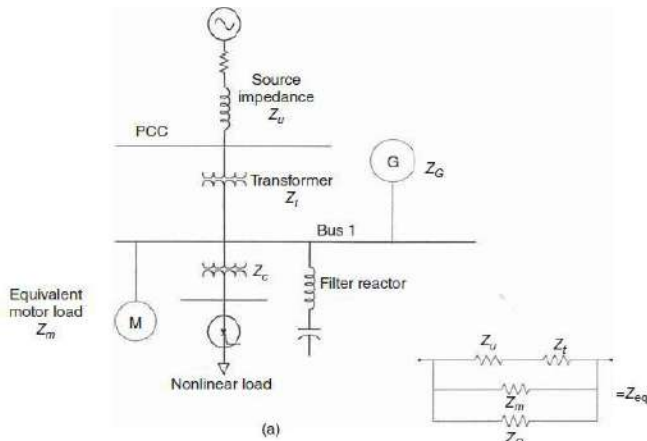


Fig.3(a): Connections of an ST filter, harmonic source in a distribution system.

Source: [22].

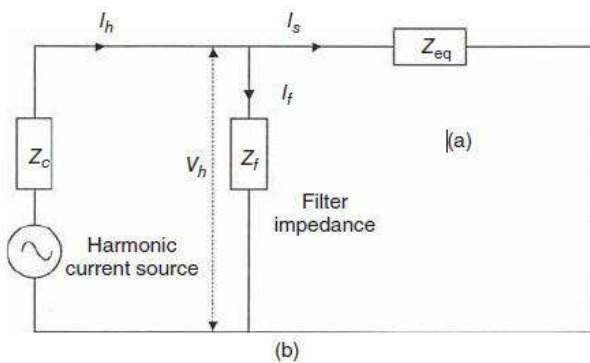


Fig.3(b): Equivalent circuit looking from harmonic injection as the source.

Source: [22].

We alluded to this concept in Chapter 6 in connection with active filters, the IEEE harmonic limits of TDD [27] are based on this concept. The higher is the short-circuit power of the source, the higher is the permissible TDD.

In an ST filter, as the inductive and capacitive impedances are equal at the resonant frequency, the impedance is given by the resistance R:

$$Z = R + j\omega_n L + \frac{1}{j\omega_n C} \quad (9)$$

At resonant frequency ω_n , $Z = R$.

The following parameters can be defined:

ω_n is the tuned angular frequency in radians and is given by

$$\omega_n = \frac{1}{\sqrt{LC}} \quad (10)$$

X_0 is the reactance of the inductor or capacitor at the tuned angular frequency. Here, $n = fn/f$, where fn is the

filter-tuned frequency and f is the power system frequency.

$$X_0 = \omega_n L = \frac{1}{\omega_n C} = \sqrt{\frac{L}{C}} \text{ and } \omega_n = \sqrt{\frac{1}{LC}} \quad (11)$$

The quality factor of the tuning reactor is defined as

$$Q = \frac{X_0}{R} = \frac{\sqrt{L/C}}{R} \quad (12)$$

It determines the sharpness of tuning, see Chapter 3. The pass band is bounded by frequencies at which

$$|Z_f| = \sqrt{2}R \quad (13)$$

$$\delta = \frac{\omega - \omega_n}{\omega_n} \quad (14)$$

$$\omega = \omega_n(1 + \delta)$$

At these frequencies, the net reactance equals resistance, capacitive on one side, and inductive on the other side. If it is defined as the deviation per unit from the tuned frequency, then for small frequency deviations, the impedance is approximately given by

$$|Z_f| = R\sqrt{1 + 4\delta^2 Q^2} = X_0\sqrt{Q^{-2} + 4\delta^2} \quad (15)$$

To minimize the harmonic voltage, Z_f should be reduced or the filter admittance should be high as compared to the system admittance.

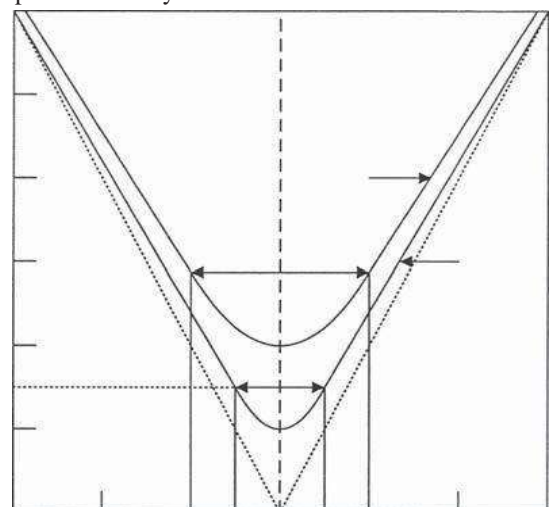


Fig.4: Response of an ST shunt filter showing pass band and asymptotes.

Source [28].

The plot of the impedance is shown in Fig. 4 [28]. The sharpness of tuning is dependent on R as well as on X_0 , and the impedance of the filter at its resonant frequency can be reduced by reducing these. The asymptotes are at

$$|X_f| = \pm 2X_0|\delta| \quad (16)$$

The edges of the pass band are at $\delta = \pm 1/2Q$ and width = $1/Q$. In Fig. 15.4, curve A is for $R = 5$ ohms, $X_0 = 500$ ohms, and $Q = 100$, with asymptotes and pass band, as shown. Curve B is for $R = 10$ ohms, $X_0 = 500$ ohms, and $Q = 50$. These two curves have the same asymptotes. The resistance, therefore, affects sharpness of tuning.

In terms of admittances

$$Y_f = G_f + jB_f \\ = \frac{Q}{X_0(1 + 4\delta^2 Q^2)} - \frac{2\delta Q^2}{X(1 + 4\delta^2 Q^2)} \quad (17)$$

The harmonic voltage at filter bus is

$$V_h = \frac{I_h}{Y_h} \quad (18)$$

For minimum voltage distortion, the overall admittance of filter should be increased. The impedance loci indicate that generally the harmonic impedances can be defined in a region of R, jX , determined by two straight lines and a circle passing through the origin.

The other types of filters that were used in article [29] have the same characteristics of the search:

- a) *Filters tuned*
- b) *Damped Filter (High pass)*
- c) *d) Third-order filter*
- d) *C type filter*

III. MATERIAL AND METHODS

The research follows the same methodology of Article [29]:

- A. *Formulation of the problem*
- B. *Problem variables*

The chromosome representing an individual's data consists of an arrangement of the K elements, where each Sk element as shown in Table 1 is an arrangement of integer and real data representing the various parameters of the harmonic filter to be located on bar k .

Table.1: Variables that describe a filter represented on the chromosome.

Variable	Description
Cfg	ConfigurationType (1, 2, 3, 4)
m	Number of branches tuned (if it is type 1 filter)
Qc	Total reactive power in capacitors
Fd_1, \dots, Fd_{w+1}	Factors for the distribution of reactive power among all branches
Fq_1, \dots, Fq_{w+3}	Tuning frequencies of all branches
Q_1, \dots, Q_{w+3}	Quality factors of all branches

Source: [29].

IV. RESULTS AND DISCUSSIONS

The results of the research follows the same methodology of article [29] using case 2.

NPV of filters design [29] and equations (8), (9), (10), (11), (12), (13), (14), (15), (16), (17), (18), (19), (20), (21), (22), (23), (24), (25), (26) and (27).

4.1 OTIMIZATION ALGORITHM

For the problem formulated for the design of filters whose nonlinear features with real and integer variables whose solution requires an optimization algorithm using the NSGA II. The types of optimization problems present several objective functions, which are almost always in conflict, and if one wishes to optimize simultaneously in this case, in an innovative way, it presents three objective functions ($f1$, $f2$ and $f3$). In multiobjective optimization, the notion of optimal solution is replaced by the notion of Pareto unpaired or optimal solution [29][31].

4.2 APPLICATION EXAMPLES

This example corresponds to an industry that contains medium and low voltage loads. The electrical system uses a primary distribution network of 4160V that feeds the medium voltage loads and four substations that feed the loads of 480V. The nonlinear loads are concentrated in the low voltage part and are formed by three-phase six-pulse converters.

In this case it is considered that the voltage of all the nodes of the network must comply with the quality indicators as established in the standard [32]. The industrial plant is described according to the singleline diagram shown in Figure 5.

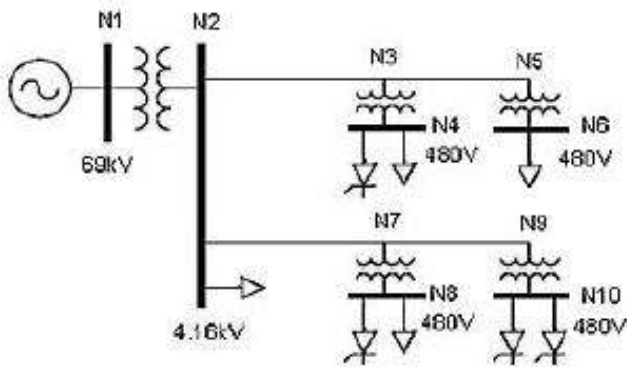


Fig.5: Industrial plant single line diagram.

Source: [29].

Os dados que descrevem a instalação industrial estão apresentados e para o processo de otimização, são considerados cinco cenários de operação possíveis, os quais são apresentados na Tabela 2.

Tabela 2: Cenários para as análises.

Parâmetro	Cenários				
	1	2	3	4	5
Duração diária do cenário (h/dia)	6	10	8	0	0
Depreciação da capacitância dos filtros ΔC (%)	0	0	0	0	10
Depreciação da indutância dos filtros ΔL (%)	0	0	0	-5	5
MVA de curto-circuito no PCC (MVA)	250	250	250	125	125

Source: Authors, (2019).

The first three scenarios are load regimes characteristic of a normal industrial plant work day, considered to evaluate the 12-month energy bill with 30 days. These scenarios do not consider depreciation of the filters components, since they assume that they exactly maintain their design parameters. Scenarios four and five are pessimistic conditions of network operation with reduced short-circuit MVA in the PCC [29]. In addition, these scenarios add a depreciation of capacitance (ΔC) and inductance (ΔL) for all filters that are installed. The bars (N4, N8 and N10) were selected for the installation of filters considering that they are the ones that feed nonlinear loads [29]. To evaluate the economic effectiveness (NPV) of the compensation project, it was considered a duration of five years, with a rate of return of 10% per year. The following cases were analyzed [30]:

1) Design of filters for the three characteristic scenarios;

2) Design of filters for the five possible scenarios.

In both cases, the limits of voltage harmonics [32] were used as energy quality constraints.

In addition, 100 generations of the algorithm were performed, with a population of 500 individuals.

4.3 DESIGN OF THE FILTERS FOR THE THREE CHARACTERISTIC SCENARIOS

In this case, by adding two non-characteristic scenarios that complicate the problem, they may have a modern scenario for all scenarios. As the voltage distortion rates increased, as in the previous case, there were no violations of the PRODIST Module 8 standard, which can be seen in Table 3.

Table 3: Initial results (case 2).

Parâmetro	Valor
Custo anual da energia (\$/ano)	840124
Máximo TDD (%)	7.412
Máximo IDD (%)	6.498
Máximo THD (%)	9.090
Máximo IHD (%)	6.818
Fator de potencia	0.797

Source: Authors, (2019).

According to [29][31], these levels of distortion are within the established limits. Finished 100 generations, the genetic algorithm produced a population of 500 solutions, for example. Extracting only viable solutions, the results obtained are shown in 9 for the Pareto frontier of the problem, as shown in figure 6.

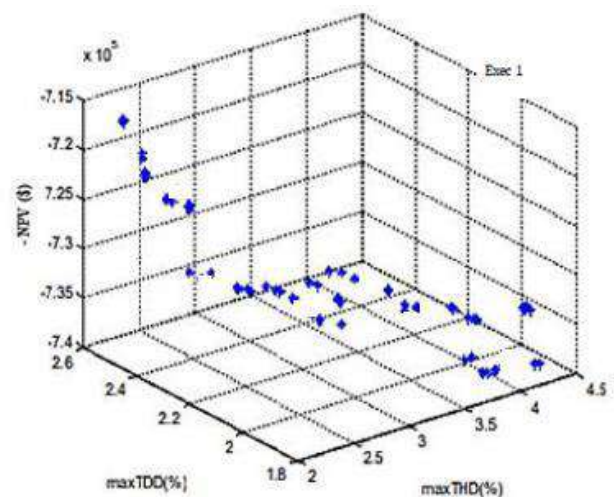


Fig.6: Pareto frontier.

Source: Authors, (2019).

In order to select the possible solution to the problem, considering that the PRODIST-Module 8 standard only restricts the voltage distortion, we can order the solutions in ascending order of $maxTHD$, $maxTDD$

and $-NPV$ respectively. Figure 8 shows the ordered solutions, where $asmaxTHD$ increases, $maxTDD$ and $-NPV$ decrease [29][30].

A Figura 7 mostra as soluções ordenadas para o novo caso, onde se repete o comportamento observado previamente.

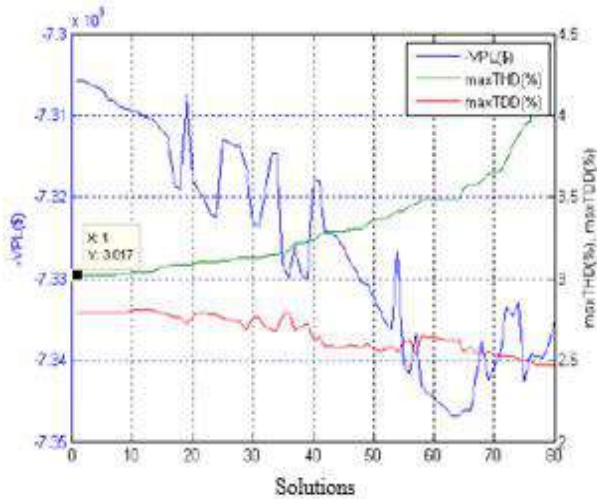


Fig.7: Ordered solutions (case 2).

Source: Authors, (2019).

The solution chosen, shown in Figure 7, is composed of the filters whose parameters are shown in Table 4.

Table 4: Parameters of selected filters (case 2).

Barra	Parâmetro	Ramo 1	Ramo 2
N4	Tipo	2ª ordem	
	Capacitor	8x50 kvar	
	Frequência	5.6	
	Fator de qualidade	5.8	
N8	Tipo	2ª ordem	
	Capacitor	4x50 kvar	
	Frequência	5.5	
	Fator de qualidade	5.8	
N10	Tipo	sintonizado	sintonizado
	Capacitor	4x50 kvar	2x50 kvar
	Frequência	4.7	6.6
	Fator de qualidade	41.3	22.7

Source: Authors, (2019).

For these filters, the results of Table 5 are obtained, which demonstrate an appreciable reduction of the distortion limits, and a good NPV of the design is expected.

Table 5: Final results (case 2).

Parameters	Value	%
Annual energy cost (\$/year)	637442	75.875
Max TDD (%)	2.795	37.711
Max IDD (%)	2.481	38.177
Max THD (%)	3.017	33.191
Max IHD (%)	2.594	38.040
Power Factor	0,982	123.218
Cost of filter investments (\$)	37751	
Project NPV	739857	

Source: Authors, (2019).

As can be seen, in Figure 8, these filters have a very stable performance against the variations of their parameters L and C.

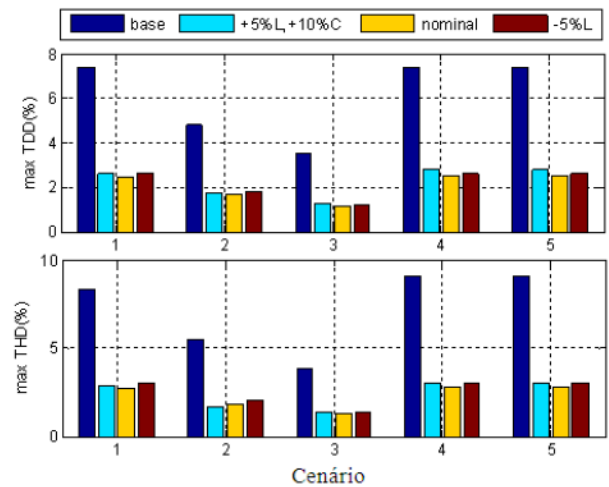


Fig.8: Results with filter depreciation (case 2).

Source: Authors, (2019).

Thus, the frequency sweep results in Figure 9 show that the impedance peaks do not match the present harmonics and therefore the selected filters can operate without problems.

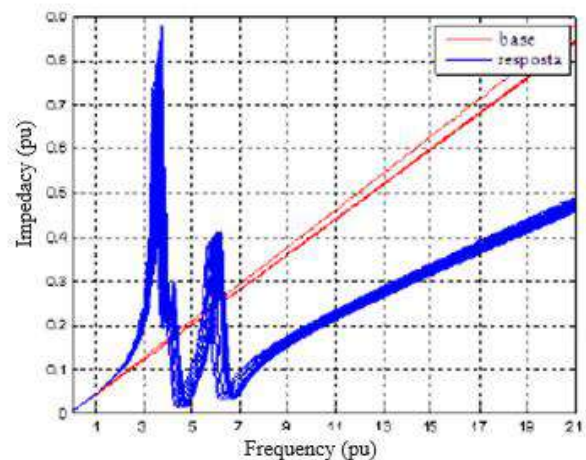


Fig.9: Frequency scanning on bar N10.

Source: Authors, (2019).

As cases 1 [29] and 2 are very similar, the results were compared for the TDD and THD distortion rates of the solution variants applied in case 2, hoping that the variant found in this case is better, especially for the scenarios 4 and 5. The results are shown in Table 6.

Table 6: Comparison between solutions 1 and 2 for case 2.

Index	Solution	Scenario					Max
		1	2	3	4	5	
maxTDD	1	2.596	1.699	1.234	2.445	4.450	4.450
	2	2.469	1.655	1.139	2.617	2.795	2.795
maxTHD	1	2.346	1.564	1.100	2.369	4.134	4.134
	2	2.742	1.834	1.280	3.017	3.017	3.017

Source: Authors, (2019).

As expected, the solution of case 2 behaves better than the solution obtained for case 1.

V. CONCLUSION

From the results obtained, the following conclusions can be drawn:

1) In order to obtain good results, it is necessary to use populations that exceed several times the number of variables of the problem. The cases considered with three filters were applied with populations of 500 elements (individuals per variable).

2) The responses obtained usually use capacitors of different powers for the different branches of a filter. This is different from the proposals of several authors, who use the same capacitors for the different branches.

3) Due to the characteristics of the genetic algorithms, there is no guarantee that the type of filter configuration chosen by the algorithm is the best. It is noticed that the algorithm will produce a set of good solutions to the problem. Therefore, the program (NSGA II) has the option to restrict the possible solutions to choose and prefix the desired configuration in each case.

4) It is necessary to improve the tools for the selection of the final variant, from the set of viable solutions, determined by NSGA II.

5) The solutions obtained with the algorithm should be analyzed for different conditions of capacitance depreciation and inductance of the filters and, in this way, correctly judge the performance of the selected filters.

6) The optimization algorithm (NSGA II) developed can adapt significantly to the parallel programming with which it would drastically reduce the execution time of the algorithm.

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REFERENCES

- [1] Weedy, Birron Mathew et al. Electric power systems. John Wiley & Sons, 2012.
- [2] Whitaker, Jerry C. AC power systems handbook. CRC Press, 2006.
- [3] Qazi, Sajid Hussain; Mustafa, Mohd Wazir. Review on active filters and its performance with grid connected fixed and variable speed wind turbine generator. Renewable and Sustainable Energy Reviews, v. 57, p. 420-438, 2016.
- [4] Heydt, Gerald Thomas. The next generation of power distribution systems. IEEE Transactions on Smart Grid, v. 1, n. 3, p. 225-235, 2010.
- [5] Ghosh, Arindam; Ledwich, Gerard. Power quality enhancement using custom power devices. Springer Science & Business Media, 2012.
- [6] Kothari, Dwarkadas Pralhadas et al. Modern power system analysis. Tata McGraw-Hill Education, 2011.
- [7] Morán, Luis A. et al. Using active power filters to improve power quality. In: 5th Brazilian Power Electronics Conference. 1999. p. 501-511.
- [8] Duffey, Christopher K.; Stratford, Ray P. Update of harmonic standard IEEE-519: IEEE recommended practices and requirements for harmonic control in electric power systems. IEEE Transactions on Industry Applications, v. 25, n. 6, p. 1025-1034, 1989.
- [9] Cristaldi, Loredana; Ferrero, Alessandro; Salicone, Simona. A distributed system for electric power quality measurement. IEEE Transactions on Instrumentation and Measurement, v. 51, n. 4, p. 776-781, 2002.
- [10] [10] Gomez-Exposito, Antonio; Conejo, Antonio J.; Canizares, Claudio. Electric energy systems: analysis and operation. CRC press, 2018.
- [11] [11] Sankaran, C. Power quality. CRC press, 2001.
- [12] [12] Das, J. C. Passive filters-potentialities and limitations. IEEE Transactions on Industry Applications, v. 40, n. 1, p. 232-241, 2004.
- [13] [13] Gonzalez, Damian A.; Mccall, John C. Design of filters to reduce harmonic distortion in industrial power systems. IEEE Transactions on Industry Applications, n. 3, p. 504-511, 1987.
- [14] Arrillaga, Jos; Watson, Neville R. Power system harmonics. John Wiley & Sons, 2004.
- [15] Ellis, Robert G. Harmonic analysis of industrial power systems. IEEE Transactions on Industry Applications, v. 32, n. 2, p. 417-421, 1996.
- [16] Kuffel, John; Kuffel, Peter. High voltage engineering fundamentals. Elsevier, 2000.
- [17] Alemam, Ali Mohammednoor Ali et al. Power System Harmonics Sources, Effects and Elimination. 2018. Tese de Doutorado. Sudan University of Science and Technology.

- [18] Radhakrishnan, Krishna. Passive Filter Design and Optimisation for Harmonic Mitigation in Wind Power Plants. 2016. Dissertação de Mestrado. NTNU.
- [19] Vedam, R. Sastry; Sarma, Mulukutla S. Power quality: Var compensation in power systems. CRC press, 2008.
- [20] Quintana Barcia, Pablo José. Study on active filtering of current harmonics content in public lighting systems. 2013.
- [21] Tan, Adnan; Bayindir, K. Çağatay. Modeling and analysis of power quality problems caused by coreless induction melting furnace connected to distribution network. *Electrical Engineering*, v. 96, n. 3, p. 239-253, 2014.
- [22] Das, J. C. Power system harmonics and passive filter designs. John Wiley & Sons, 2015.
- [23] Leite, J. C. Abril, Ignácio Perez, Tostes, Maria Emília de Lima and Oliveira, Roberto Célio Limão de. Multi-objective optimization of passive filters in industrial power systems. *Electrical Engineering*. Springer. 2016. DOI: 10.1007/s00202-016-0420-3. Volume 99, Issue 1, pp 387–395.
- [24] Chapman, David. Harmonics causes and effects. *Power Quality Application Guide*, v. 3, p. 4-5, 2001.
- [25] Merhej, Saad J.; Nichols, William H. Harmonic filtering for the offshore industry. *IEEE transactions on industry applications*, v. 30, n. 3, p. 533-542, 1994.
- [26] Beres, Remus Narcis et al. A review of passive power filters for three-phase grid-connected voltage-source converters. *IEEE Journal of Emerging and Selected Topics in Power Electronics*, v. 4, n. 1, p. 54-69, 2015.
- [27] IEEE 519-2014. Recommended practice and requirements for harmonic control in electrical systems, 1992. Review to 2014.
- [28] E.W. Kimbark. *Direct Current Transmission*, Chapter 8. John Wiley, New York, 1971.
- [29] Leite, J. C et. al.. Approach of Passive Filters using NSGA II in industrial installations: Part I. *International Journal of Advanced Engineering Research and Science (IJAERS)*. [Vol-5, Issue-8, Aug- 2018].
- [30] Kawann, C., & Emanuel, A. E. (1996). Passive shunt harmonic filters for low and medium voltage: A cost comparison study. *IEEE Transactions on Power Systems*, 11(4), 1825-1831.
- [31] ANEEL, P. d. D. d. E. (2018). Elétrica no Sistema Elétrico Nacional–PRODIST: Módulo 8-Qualidade de Energia Elétrica. *Revisão*, 10, 88.

Small Leaves: Children in the Temples of Candomblé in the Backwoods of Brazil

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Abstract— *This study is a reflection of the realities experienced by three children and one adolescent from three Temples of Candomblé in the cities of Juazeiro / BA, Petrolina / PE and Paulo Afonso / BA (Sertão Nordestino Brasileiro), whose main objective was to describe, under their own perceptions, how their relationships are established in the process of participation (initiation, teaching and learning of knowledge) in these spaces of Afro-Brazilian religious cults. Two children were interviewed by ethnographic research in Terreiro Bandalecôngo de Mãe Maria de Tempo, in Juazeiro / BA; a child in the Terreiro Ilé Dará Axé Omo Logum Edé of Pai Adilson, in Petrolina / PE and; a teenager in the Abassá of the Goddess Oxum de Idjemim, in Paulo Afonso / BA. The method used was that of Content Analysis, according to Bardin (2016). It was concluded that the relationships involving children, childhood, religion, family and community are fundamental for the construction and (re) elaboration of knowledge and to know in the process of teaching and learning inside and outside the temples.*

Keywords— *Children and adolescents. Temples of Candomblé. Participation and initiation. To know. Backwoods of Brazil.*

I. INTRODUCTION

Corsaro (2011) concluded that, through the traditional theoretical conception, in which much of the sociological thinking about children and infants derives from the theoretical work on socialization, a process by which children adapt and internalize society, the child is seen as society, which must be shaped and guided by external forces in order to become a fully functional member. He tells us that in the deterministic model the

child plays primarily a passive role, in which he is both a "beginner" with potential to contribute to the maintenance of society and an "untamed threat", which must be controlled through careful training. Still for this author, in the constructivist model, the child is seen as an active agent and an avid apprentice, perspective in which the child actively builds his social world and his place in it.

Caputo (2012) reports that, as a researcher, she tries to "frame" aspects of reality and to cut down from

the observed immensity a smaller immensity, on which one can look more closely and that the temple offered her the infinite, but focused on her attention on talking, interviewing and photographing especially the children, relating them to the community of the temple as a whole.

Taking these conceptions as a guide to arrive at a possible description / understanding of the processes that involve children in learning and in the socialization of the knowledge and knowledge of the religions of African matrices, more specifically Candomblé in the Brazilian semiarid region, semi-structured interviews with

three children and one adolescent from three Candomblé temples in three Brazilian cities.

From Bandalecôngo temple (Juazeiro / BA), the children interviewed were Kerlen, eight years old, initiated in candomblé at age seven, and Naian ten years old, started in religion when she was six years old; From the Temple Ilê Dará Axé Omo Logum Edé (Petrolina / PE), the seven-year-old David, who started at the age of four, ; From the Abassá of the Goddess Oxum de Idjemim (Paulo Afonso / BA), the content analyzed was that of Leticia, thirteen years old, initiated at the age of ten.

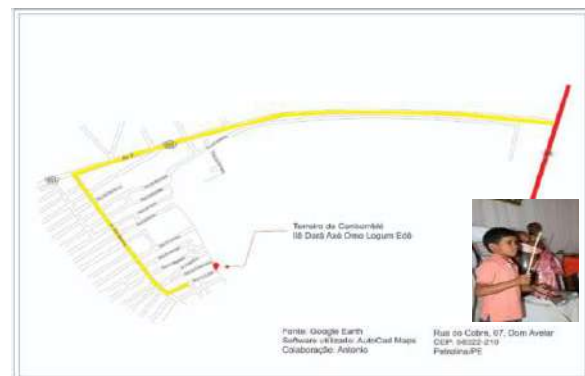
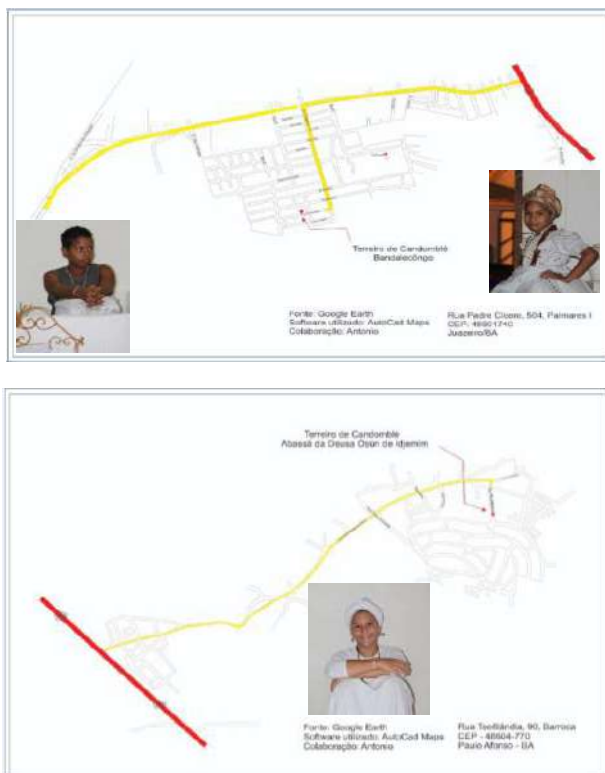


Fig.1 – Terrestrial location maps: Bandalecôngo with Naian and Kerlen; Ilê Dará Axé Omo Logum Edé with Davi and; Abassá of the Goddess Oxum of Idjemim with Leticia. (Archives of authrs)

II. MATERIALS AND METHOD

Based on the identification of the scenario, the research adopted as a strategy data collection as a case study, considered by Oliveira (2008) as an initial study of few known problems or when there are few or a single case available to study ", or by the understanding of GIL (2010) that is based on a strategy for very numerous data and obtained in different ways.

According to an ethnographic study, the research coincides with the idea of Macedo (2015) evidencing that the experience of the other is placed in the research with the status of a different way of creation and apprehension of knowledge and that this experience happens in between us, in the between-two, provided by interactions in the same research process. For the author, the researcher and the social actors involved, via generative encounters, produce the heuristic of research,

the cognitive modes, very intuitively, to arrive at the discoveries.

The data collected by semi-structured interviews were grouped, systematized and categorized in thematic axes, then in analytical topics and finally in this scientific production (article). The analysis of the data collected in the field was based on the Content Analysis - French Line AC, based on the studies of Bardin (2016), which proposes the categorization of discourse content as one of the possible methods of analysis.

III. RESULTS AND DISCUSSION
Childhood in Human Ecology of Candomblé temples in the semiarid of brazil

Kileuy and Oxaguia (2011) argue that the word "candomblé" seems to have originated from a term of the Bantu nation, candombe, and translated as dance and batuque, referring to jokes, parties, meetings, slaves

feasts, in the slave quarters, in their spare moments. Also, it is a religion that was created in Brazil through the cultural, religious and philosophical heritage brought by Africans, adapted to the environmental conditions and with the primary function of worship the divinities - iniquices, orixás or vuduns -, beings that are the strength and power of nature.

Regarding his activities in the temple, Kerlen, a child from Bandalecôngo's temple, says that he helps Yalorixá by separating food and things from cleanings to get through the body when cleaning or initiating, and that her temple is candomblé. Her imagery seems surprising when she elaborates her Human Ecology by linking Africa to the Northeastern Semiarid by describing that she likes zebras, which has two dogs and her palate is attracted by the sweet taste of grape fruit.

Naian, also a child of Bandalecôngo, says that inside the temple, he does many things: "I play, when there is a party, help my mother in at the ebó ritual, move the ebó from a place to another" And that he himself defines himself, functions, such as a "Keligebo"². The small candomblecist claims to be also Ogã.

Naian still claims to be from Candomblé, inferring distinction between candomblé³ and Umbanda: "It's that he sings some songs that are already very different in Umbanda." He also says that he likes and cares about nature and plants and that between dealing with "bugs" and with people, it's easier with the bugs, because the people from outside, keep saying things about us. Criticizing".

Davi, child of Ilê Axé Dará Omo Logum Edé, affirms to be Ogã⁴, who likes to play drums and that deal

with animals in a natural way. He also assumes that he is from Candomblé, verbalizing his conceptual defense of what differentiates Candomblé from Umbanda: "Umbanda plays drums and Candomblé plays atabaque". He also describes how he takes care of the plants: "I drink water and leave it in the sun." And why I like snakes and not fear them: "because I snake's", alluding to his head Orixá, Oxumaré.

The child sketches naturality when he speaks about his father and his uncles (who are also ogans) in the rituals and already carries out the immolations to offer to the deities. In the position of Alabê, Davi helps his father and uncles in specific jobs of Ogã Axogum.

In this respect Caputo (2012) tells us that:

There are innumerable children and adolescents in the afro-Brazilian cults community. They are either from the family of the father or mother of a saint or are attached to the sons and daughters of the saint of the temples. Like adults, these children are initiated into candomblé, perform specific functions, receive positions in the hierarchy of the temples and manifest pride in their religion (CAPUTO, 2012).

The adolescent abbess of the Abassá of the Goddess Oxum de Edjemim, Leticia Maria, when asked about what she does in the temple, she was a little shy and / or tense enough to answer "I am Abián in the temple." She says she never went to a Umbanda temple, but with aplomb She assumes that She is from Candomblé and goes on to argue:

For me candomblé is a religion that is equal to the Catholic. But in the Catholic the names of the saints are others. Our Lady of Aparecida is Iemanjá, Our Lady of the Conception is Oxum. It's different, but it's the same. And the language is different, but it is based on the Catholic Church. It is a ritual of faith (LETÍCIA, 08/08/17).

She makes an association in the relationship of religion with nature and warns about the ecological behavior of man on the elements:

It is very much the same because the snake, for example, has a god who dominates it, which is Oxumaré. There is the forest that manages the Oxossi and Ossaim leaves. There is mud that is the Nanã, there is the freshwater river that is the Oxum. There is salt water that is Iemanjá. Everything is all about the reality of Candomblé. I think candomblé is more the reality of nature than the Catholic church.

¹For Kiley and Oxaguã (2011) the sense of "doing ebó" is based on rituals that allow the strengthening of the spiritual life, but also part of the rituals that help to remove the negative forces that bring instability. They are elements that can be offered to Exu, eguns and Edus and also to the orixás and other deities.

²From the speech of Naian the sense apprehended is the one who deals with ebó, although according to his mother kota he doesn't detain the position of kelegebo.

³For Prandi (2003), Umbanda is an Afro-Brazilian branch and was formed in the 20th century in the Southeast, and represents a synthesis of the ancient Candomblé of Bahia, transplanted to Rio de Janeiro in the passage from the 19th to the 20th centuries, the Kardecist spiritualism, which came from France at the end of the nineteenth century (MARQUES and NOVAES, 2015, p.33).

⁴Male authorities, hierarchical rank below the priest / priestess, and their direct auxiliaries, so called by the Yoruba people. In the fon nation they are called runtó / huntó and in the bantu nation they are called xicaringome / xincarangoma. These men, like the equedes, do not enter into a trance (Kiley and Oxaguã, 2011, 60).

But man has to be aware of what he is doing.

Example: Is there a god that will tell you what you have to do? No! It has to come from you, not from others. Because more and more people find a cleared forest. The people always ask why it does not rain or why it rained there and it did not rain here. Maybe where it did not rain was where everything was cleared and where it rained is because they preserved it (LITICIA, 13/08/17).

Corsaro (2011) describes us that interpretive reproduction views the integration of children into their cultures as reproductive rather than linear. For him, from this reproductive perspective, children do not simply imitate or internalize the world around them. According to the author, they (children) strive to interpret or give meaning to their culture and to participate in it. In this attempt to make sense of the adult world, children collectively produce their own worlds and cultures of peers.

According to Tomaz (2014), the symbolic relationship established between traditional peoples and communities and nature, constitutes an ethnoecology of preservation and care and that the vulnerability to which they are subjected can be understood by the historical construction in which these differentiated groups had to submit, from Brazil colony to contemporaneity.

Higino (2011) concludes that the social space of the temple, is a religious space and also an educational one, since it is in the coexistence that the exchange of knowledge is established, since the religious heritage brings with it, throughout the history, a context of resistances and social oppressions that lead the Negro to exercise his citizenship and define his identity and conscience. For the author in the education of Candomblé there are values transmitted because they are linked to spirituality and the basis of their existence is the transmission of fundamentals and doctrines, orally, by the elders.

Thus, in the children's and adolescent's speech, we can see an interaction that directly relates religion, nature (environment), society / community, cultural symbols in their own conditions as a child in an interpretative perspective, following Corsário (2011), because of adult cultural reality participate, but also re-elaborate and re-signify their interaction, describing this relationship as the driving force that binds them, in rituals, also to the deities, but mainly fun, as ecological connection in the representation of Orixás that have as main characteristic care and / or symbolism with the elements of nature, for example, Oxumarê (whose representation is the snake) and / or Oxossi (guardian of

the woods), among others, in a connection between the human and the sacred.

Initiation in Candomblé: Perceptions of Children from Brazilian semi-arid temple

Leonardo Boff, in dealing with the ethical principles of unlimited responsibility and respect, tells us that "responsibility, fundamentally, has to do with the conscience of the human being, of him realizing the consequences of his acts" and that respect is "the attitude towards the other: when we respect, we guarantee the right that things exist" (BOFF, s / d).⁵

In "The Voice of Time: the Winds of the Bandalecôngo temple"⁶ the Yalorixá Mother Mary of Time tells us that Initiation is the birth to a new life and that in the houses of nation Keto, there is the tradition of shaving the head of the iaô, during the process of making the saint, while the person is collected (period ranging from 14, 21 and 30 days) depending on the particularities of the initiate's personal life. For her, the scraping of the head means that that person is leaving everything to start again to live with a clean and pure head to receive the teachings that will be governed by the Orixá of his Ori.⁷ (MARQUES, ALVES and MARQUES, 2017).

As the children and adolescents of the semi-arid Brazilian temples perceive themselves as part of a religion with many marks of resistance due to prejudice and discrimination that are still violently stuck in the memories, bodies and established human relationships, including (schools), and how they describe their experiences is what the interviewees of this research reveal.

According to Kerlen, at school the students know she is a candomblecista and that, "they question her like this: Kerlen, how do you dance? Then I'm kind of lost. Then I will soon do my activity." In this respect, it is pertinent that the Yalorixá Mother Mary of Time, who is Mother of Saint and biological grandmother of Kerlen bear his testimony at the stage in which Kerlen made himself "in the Holy:

⁵This is a documentary available on networks and social platforms, which was accessed on 09-02-2018 (<https://www.youtube.com/watch?v=6YFTh2yEPIk>), but does not have the date of its production.

⁶Book organized by Juracy Marques, Maria Rosa de Almeida Alves and Robson Marques.

⁷It is the name of our physical head for the Yoruba; camutuê or mutuê for the bantus; and is for the Fon nation. The ori is a divinity that serves only his son, since it is individual and unitary (KILEUY and OXAGUIÁ, 2011).

Kerlen shaved her head, went to school, she had a cap. We made a nice little white cap, put it on and it was like a toupee, and they always asked why she did not take off her cap. So she said, "No, no problem, you want to see?" Then she took it off. She talks too much. She also said, "Listen, there's nothing much. Look! That's hair, hair grows out fast. It's going to be all over again, my curls will come back all over again." She is like that (MOTHER MARIA DE TEMPO, 07/17/17).

It is important to point out that one of the hallmarks of the initiation process in Candomblé, also in the Brazilian semi-arid, is the rite of shaving the head and the recollection in a room (Honkó, camarinha) for learning fundamentals such as greetings, songs, dances, what to eat or stop eating to be in harmony with the Orixá that will govern the life of the initiate from the making. This process is followed and directed directly and constantly throughout the period of recollection by a person of great doctrinal knowledge within the temple called Makota or Mother Cota. And, because it characterizes, especially in long-haired women, a radical change of vision has been described as the most common form of prejudice, discrimination and intolerance that people in candomblé experience.

From his process of initiation into religion what Kerlen describes from his memoirs is that he began at the age of seven, who attended a party in the hall of the temple, which had many people and who did not wonder about the shaved head because "the hair grew out and at school no one said anything." As for his head guides, he reveals that they are Iansan and Oxossi.

Naian relates a situation at school with her colleague when she was asked if she had any problem with being a candomblecist:

If so ...? It was just once that I told my classmate. But I asked him not to tell anyone. Then he said he did not like my religion, that he was my best friend at school. Then he said that I was a sorcerer, that I was going to cast a spell on him. Then I did not like it. Then I ended friendship with him. Then he threw a stone at me. Then I did not talk to him anymore (NAIAN, 07/23/17).

And when asked if his teachers and other colleagues at school know that he is a candomblecist, he says: "Only my cousin." She also says she does not tell her colleagues and teachers, only the principal, because she does not have the courage to tell them. "Because they keep calling me a sorcerer and I do not like it. And I do not like messing around."

But it is when Naian tries to describe what he feels when he is called sorcerer that we perceive a possible disorder in his attempt of conceptual (re)elaboration and of religious meaning: "spell maker is ... is not ... it is the same thing of Candomblecist .. I do not know how to explain well."

Asked about his inspiration to be from candomblé he says: "it is because I saw my mother there then I encouraged myself a lot. Then I wanted to join them." "For me ... I do not remember, but I think I just chose it." And he reveals that his front guides are: "Oxossi and Oxalá, Iemanjá and Oxum come later."

It is inferred from the content of Naian's statements that his religious reality is in constant conflict with the glances of his religion in the daily life at school by the relation reported with his colleague but that it is sustained by the conviction of the experiences with his biological mother and also a saint.

David told only that he has a colleague who is from another temple, and at school nobody did not notice anything different with him. He, with unusual responses of his age, says that it was from his Uncle Mida that he learned to play. And when asked what methods his uncle used to teach him, true and childish, he answers: "Teaching! I looked and learned." This speech translates one of the ways in which education in the temples occurs: still strongly based on oral tradition, children just observe, listen and learn.

Leticia reveals to us that for making part of Candomblé temple has already been discriminated against, has already gone through some prejudiced situation:

There's a classmate of mine, from school, that's a Christian. She does not believe in this and such. If I wear a necklace like that I'm already a macumba maker, I'm already the one who casts spell on people and such. Then when I got there she would start saying things, start laughing at me. Then, at religion class, the teacher started talking about Candomblé and asked who was from Candomblé. I said I was and there was another classmate who was too. Then the Christian girl started talking and all. Then I said: the same way I respect your religion, you should respect mine. I make my choice, you make yours. I told her that and nothing more. And today she is ok about my religion. She never said anything again. I wear the necklace and such, I no longer said anything again (LETÍCIA, 08/08/17).

For Leticia, a situation of discrimination faced in the school, did not make her feel victimized, on the

contrary, she used the situation in the classroom to declare herself a candomblé member and have the other students respect her as such. By her statement Leticia seems to be steadfast about his religious choice and to give us a good lesson: do not shut up before the oppressor and be proud of what you do with love and devotion.

IV. FINAL CONSIDERATIONS

This work is concluded considering that, by the categorization that directed the speeches for the analyzes and according to semantic values in common, in the topic of Childhood of the Human Ecologies of the candomblé temples in semiarid, it is established that the children and the adolescent, with their interpretations and (re) elaborations of reality describe their activities in the temple while maintaining the ingenuity and purity peculiar to their ages, establishing their childhoods in the context of religiosity and also as active and creative beings.

Kerlen and David saved the verbalization of the answers, but they were very attentive and charming by the detachment in the reelaboration of their realities. The content of David's speech, especially when he reports that "Umbanda plays drums and Candomblé plays Atabaque," seems to evidence a departure from the adult argument that entities, rites, touches, songs, offerings and, more generally, the rite of shaving or not shaving the head that represents this differential (distinction between candomblé and umbanda), ratifying its authentic interpretation.

Naian also involves the musicality when it is arranged to distinguish Candomblé of Umbanda, which is very pertinent, considering its condition also of Ogan. And that most likely discrimination from people externs their religion, which makes him understand better the beings who do not judge him: non-human animals, "the bugs."

It is also necessary to consider that Leticia defines Candomblé as a ritual of faith syncretized in Catholicism (Christian religion). Associating the elements of nature with the orixás, in her discourse, she compares her religion with the Catholic Church, emphasising that candomblé experiences more the environmental reality and also relativizes the responsibilities signaling that, in the hierarchy of care, much is missing from the part of humans.

Regarding the feelings of their learning and initiation processes, the children and adolescents of the Brazilian semiarid temples describe how much play, beauty, knowledge and knowledge there is in playing drums, singing, dancing, assisting in ritualistic preparation, as well as to connect in different planes (the

terrain and carnal with the ancestral and divine) reelaborating and redefining, within its infantile perspectives, the cultural and religious realities of candomblé shared with the adults.

It can be inferred from Kerlen's speech that on the part of his colleagues there is more curiosity than discrimination when asked to see her dancing, but neither the questions nor the answers account for arguments capable of a conclusive conclusion. From Naian, it is inferred how violent it is for him to be labeled sorcerer to the point of not having the courage to tell his colleagues and teachers that he is from Candomblé, fearing more retaliation what may be putting him, like many, a position of religious invisibility.

And Leticia's sense of belonging is ratified by her entire history of dedication and reciprocity when her skills are properly cared for within the rites of her religion. Children in the temples, for Leticia, gain a sense of a reality with freedom and spontaneity in these spaces by the behaviors naturally experienced, which makes her speech special like a pearl due to the autonomy and authenticity of its descriptions.

Finally, we highlight how important it was to listen to the children themselves and the teenager about their lives, their choices and their participation in candomblé. Their speeches are strong winds against the whole mountain of prejudices, discriminations and structured intolerances against candomblé and, particularly, about the initiation of children in Afro-Brazilian religions. The constructions, interpretations and (re) elaborations of children, characteristic of the historical context of the black people confirm that the children of Candomblé of the Brazilian semiarid are Small Leaves that teach us great lessons.

REFERENCES

- [1] BARDIN, Laurence. Content analysis. Luiz Antero Reto and Augusto Pinheiro. São Paulo: Edições 70, 2016.
- [2] BOFF, Leonardo. Ethics and Ecology: Challenges of the 21st Century. Available at: <https://www.youtube.com/watch?v=6YFTh2yEPlk>. Accessed on: 09-02-2018.
- [3] CAPUTO, Stela Guedes. Education in the Terreiros and how the school relates to children from Candomblé. Rio de Janeiro: PALLAS, 2012.
- [4] CORSARO, William A. Sociology of Childhood. Translation: Lia Gabriele Regius Reis. 2. ed. Porto Alegre: Artmed, 2011.
- [5] GIL, Antonio Carlos. How to design research projects. 5. ed. São Paulo: Editora Atlas, 2010.
- [6] HIGINO, Mônica Estela Neves. The relationships of the candomblécist child in the social space of the school.

Course Completion Work (Graduation in Pedagogy) - State University of Bahia, Salvador. 2011. 43f.

- [7] KILEUY, Odé; OXAGUIÁ, Vera de. Candomblé well explained: Notions Bantu, Yoruba and Fon. BARROS, Marcelo (org.). Rio de Janeiro: Pallas, 2011.
- [8] MACEDO, Roberto Sidnei. Search the Experience. Understand / mediate experiential knowledge. Curitiba-PR: CRV, 2015.
- [9] MARQUES, Juracy; NOVAES, Joaquin (org.). CANDOMBLÉ AND UMBANDA IN SERTÃO: Social Cartography of the Candomblé and Umbanda Terreiros of Petrolina / PE and Juazeiro / BA. Paulo Afonso: SABEH, 2015. 406p.
- [10] OLIVEIRA, Valéria Rodrigues de. Demystifying the Scientific Research. Belém: University Publishing House UFPA, 2008.
- [11] TOMAZ, Alzeni de Freitas. Law and Ecology of Peoples and Traditional Communities: Essay on Ethnography. In: MARQUES, Juracy (Org.). HUMAN ECOLOGIES. Feira de Santana: UEFS Editora, 2014. 393-417.

Food Ordering Management using Recommendations

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Abstract—The proposed food ordering management system enables the customer to order the food by selecting the food items from e-menu by registering on the web application or intranet of the institute. The system is useful for a canteen which faces lot of rush during the break time and also if the work in the canteen is manual such as taking food orders at the counter and subsequently calculating the cost. Also, there is dissatisfaction among customers due to delay in orders and orders not being attended for long. These issues are addressed and solved in the proposed system. In this project, we have proposed a system that can simplify most of the manual work in the canteen, from taking orders to calculating bills. Customers can order their food from anywhere in the institution using the website, making it a hassle-free task. The placed order will be displayed on the display screen and the staff will keep the order ready for the customer. Additionally, by making use of Apriori algorithm, recommendations will be provided to the customer. The proposed system will help the administrator of the system to have a clear idea, when and which food items are preferred more on a day-to-day basis.

Keywords—Apriori algorithm, Dataset, Food ordering system, Internet, Recommendations, Smart phone.

I. INTRODUCTION

The basic problem in the food services available at canteens at various institutes and organizations are that, they are not realizing the efficiencies that would result from better applications of technology in their daily operations. In canteens, ordering of food and calculation of bill is still a problem. The problem also arises when approximation of all the stock required to be bought has to be handled based on how much food was ordered and what will be ordered the most. There are many reasons leading to delays in services such as taking orders and serving which leads to dissatisfaction among customers. The project focusses on developing a user-friendly food ordering management system for the customers as well as the administrator. The proposed system will provide facilities to the administrator such as updating the menu, based on the recommendations given by Apriori algorithm and customer-based functionalities which includes placing orders by referring to the recommendations. Ordering of food will be lot easier.

II. LITERATURE REVIEW

2.1 Past work

In the food recommendation system using clustered database [2], the data is clustered after getting the input. Cluster is a set of similar items. Using cluster database speed of the system is increased and a lot of time is saved by reducing the number of comparisons. In this system K-means is used for clustering the items. It is efficient if the

amount of data is large. Here ingredients were listed using vectoring.

In an automated food ordering system [3], which will keep track of user orders smartly. This food ordering — system will allow the user to make order or make custom food by one click. This is an android application. The front end was developed using JAVA, Android and at the backend MySQL was used.

The Zigbee based e-menu ordering system [4], is useful for all kinds of restaurants and is affordable. The system has a smarter user interface for placing orders and billing. The system includes graphical representation of menu such that it is user friendly and understandable by illiterate people also. It is low cost alternative to bigger touch panels.

The proposed automated system [5] deals with automation of restaurants, with wireless touch-panel based menu systems. The orders are taken from customers using the digitized menu. Full menu of eatable items is displayed onto the touch panel for selection. Customer orders placed through the touch panels are received in the kitchen without any involvement of waiters. Zigbee was used to have wireless link of touch panels from kitchen to restaurant tables. PIC microcontroller was used for coding of menu on touch panel. The hardware implementation was done on PCB layout. Their proposed system would also take care of all paper work i.e. data handling.

The proposed automated system [6], aimed at minimizing the number of employees at the counter, elimination of

calculation error and avoiding long queues for efficient management. This proposed system had an admin module to help do required analysis. Data mining algorithms like Apriori, K-mean are used to perform association mining and clustering operations.

III. PROPOSED SYSTEM

3.1 Types of Users and their features

3.1.1 Admin

- Update menu
- Update inventory
- Recommendation (Most Frequently Ordered Dishes)

- Sales for each day, week and month

3.1.2 Staff

- View orders placed by customer
- Prepare ordered food
- Serve food once ready

3.1.3 Customer

- View Menu
- Place an Order
- View Bill

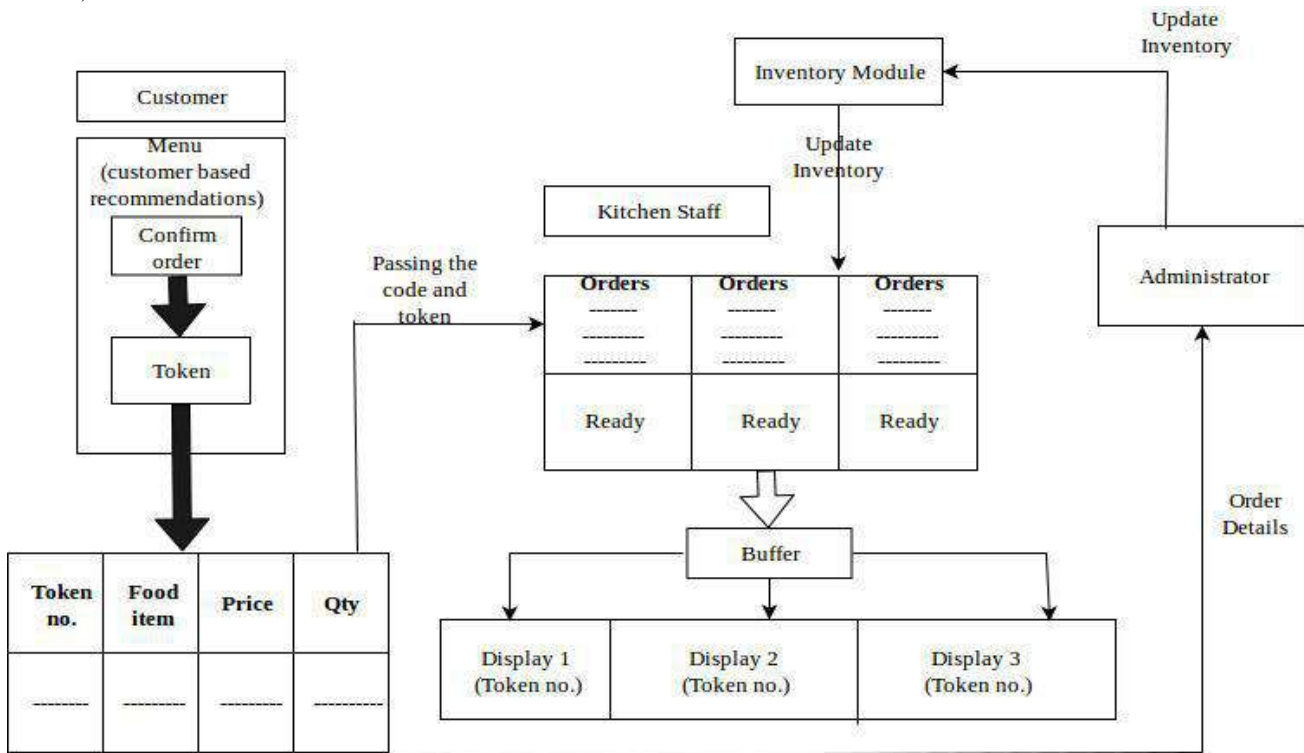


Fig 3.1 System Flow Diagram

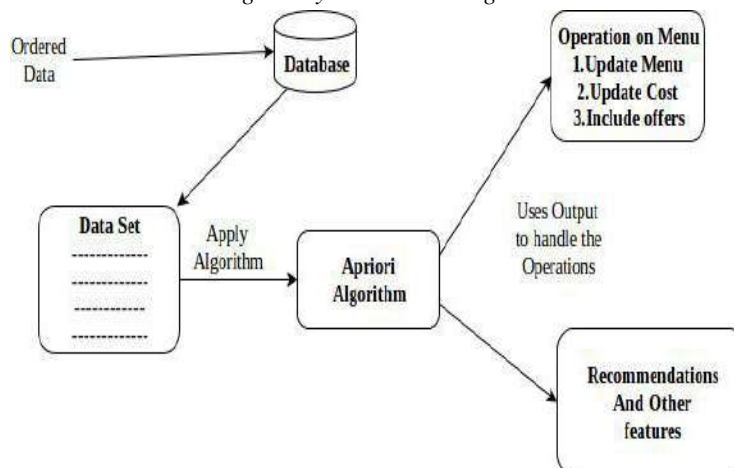


Fig 3.2 Admin Module

3.2 System flow analysis

The proposed system will be used by three types of users, mainly the customers, the kitchen or canteen staff and the administrator. Thus, the processes of the entire system can be divided into the three modules (as shown in fig 3.1) namely the admin module, the kitchen or canteen staff module and the customer module.

The food ordering management system will enable the customer to view the e-menu along with the recommendations, after viewing which, customers can place their order. Once the order is confirmed, bill will be generated along with a token.

The order data along with the token generated will be buffered and displayed onto the screen near the canteen staff. The canteen staff can view the order, prepare and serve it. The order details will be sent to the admin module for further processing.

From the above figure Fig 3.2 it can be seen that all the order details will act as an input to the Apriori algorithm and the output of the algorithm are the recommendations (as shown in fig 3.3) that are used for several purposes such as to determine most frequently ordered food item, update inventory and update menu.

IV. IMPLEMENTATION

We have developed a web-based application for our system. The implementation of the system is done using PHP, HTML, CSS, jQuery, Ajax, Bootstrap, JavaScript and the datasets are stored in MySQL database.

The hardware required for our application includes Android Smart phone and a desktop or laptop with browser and internet connection.

In our application Apriori plays an important role. We have considered six months order details of a canteen as an input to the Apriori algorithm and we obtain recommendations as shown in fig 4.1. The recommendations are the most frequently ordered food items, which the admin could use to update the menu and increase his profit.

Aitd Canteen

Home Food Items Order Details Analysis Recommendations

Inventory [Log out](#)

R. Id	Food Id	Food Name
504	2006	MON_Chole
505	2024	MON_Banana_Shake
506	2029	TUE_NonVeg_Fried_Rice
507	2032	TUE_Butterchicken
508	2035	TUE_Gobi_Mancharurian
509	2038	TUE_Chicken_Roll
510	2044	TUE_Bread
511	2045	TUE_Sprite
512	2061	WED_Biryani
513	2077	WED_Papaya_Shake
514	2087	THU_Chole
515	2098	THU_Bread
516	2109	FRI_Fried_Rice
517	2121	FRI_Chops
518	2137	SAT_NonVeg_fried_Rice
519	2138	SAT_Fish_Thali
520	2140	SAT_Butterchicken
521	2143	SAT_Gobi_Mancharurian
522	2154	SAT_Dew
523	2159	SAT_Banana_Shake
524	2001,2006	MON_Chole
525	2029,2032	TUE_NonVeg_Fried_Rice,TUE_Butterchicken
526	2061,2077	WED_Biryani,WED_Papaya_Shake

Fig. 4.1 GUI for viewing recommendations

V. CONCLUSION

Even though the existing system uses certain technologies in their food ordering system, the customer queue is not managed properly. The system proposed in this project eliminates most of the manual work and has no issues regarding customer queue, as the food is ordered online through web application. The proposed system eliminates calculation errors of bills and also provides many facilities to the admin module which includes all the required analysis of orders, profit values and stock. The proposed system uses Apriori algorithm for providing recommendation to the customers. This also makes the system more efficient as the admin has a clear idea about which food item was ordered the most. This will help him provide a better menu for the customer which will result in increase in profit. The future enhancement of the proposed system could be adding online payment system.

REFERENCES

[1] Morgan Kaufmann (2011), "Data Mining- Concepts and Techniques "3rd Edition, Jiawei Han, University of Illinois at Urbana-Champaign, Micheline Kamber, Jian Pei, Simon Fraser University.

[2] Ravinarayana A, Puja M C, Raghuvver K, information of science dept. NIE, Maysore-India,

International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper Using Clustered Database for **“Food Recommendation System”**, Volume 6, Issue 5, May 2016 ISSN: 2277 128X .

- [3] Kirti Bhandge, Tejas Shinde, Dheeraj Ingale, Neeraj Solanki, Reshma Totare , VDept. of Information Technology Engineering, AISSMS, Pune, **“A Proposed System for Touchpad Based Food Ordering System Using Android Application”**, Vol. 3, Issue 1 (Jan. - Mar. 2015) ISSN: 2347 - 8446 (Online) ISSN: 2347 - 9817 (Print).
- [4] Shabari B., Ashok Nayak, Pursuing M.Tech (ES), Working as Assistant Professor, Visvesvaraya College of Engineering and Technology (VCET), **“Zigbee based e-menu ordering system”**, Vol. 3, issue 08, August 2015, ISSN: 2348 -7550.
- [5] Aamir Nawaz, Faiz Jalil (2015) **“Touch Panel Based Modern Restaurants Automation using Zigbee Technology”** Institute of Engineering &Technology ,Gomal University, vol 3, issue 4, July 2015, ISSN 7164-0589.
- [6] Rani Kavade, Varsha Pansare, Pooja Kunjir, Ganesh Gavande March 2016, Volume 3, Issue3 **“ Proposed Automated Food Ordering System Using Data Mining Techniques”**Parvatibai Genba Moze College of Engineering, Pune, vol 3, issue 3, March 2016, ISSN 2349-5162.

Review, Analysis, and Classification of 3D Printing Literature: Types of Research and Technology Benefits

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Abstract— This paper presents a review, analysis and classification about 3D printing. Through the CAPES Sucupira platform, 124 articles with a high degree of relevance published between the years 2014 and 2018 were selected. Each of these articles was classified by means of 9 categories: study types, affiliation, approach, origin of the study, geographic scope, unit of analysis, scope, benefits and negative points. Through the results obtained, it was verified that the number of articles on 3D printing is increasing every year, which indicates its importance and popularity. Most of the time, scientific research is conducted and led by people connected to universities in Europe, Asia and the Americas. And finally, the number of citations related to the benefits of 3D printing are greater than the number of citations on the negative points of the process.

Keywords— 3D printing, additive manufacturing, literature review.

I. INTRODUCTION

The competition between companies of any industrial sector grows more and more each year. In this way, companies seek to reduce costs and deadlines and, at the same time, are pressured to develop and deliver products of high quality and performance. This competition generates the need to launch a new product in the market with a greater frequency and, consequently, the demand for new projects and development of new products grows. It is at this stage that 3D printing stands out (LOPES, 2016).

Popularly known as 3D printing, this process has many other names such as rapid prototyping (RP), additive manufacturing (AM) additive techniques, additive processes, among others (LOPES, 2016).

Within a few minutes or hours, this manufacturing process allows to produce complete products from a CAD software, using the most diverse raw materials and without a great human intervention. 3D printing has as its characteristic to construct three-dimensional pieces by means of the addition of successive thin layers, one on top of the other, until the formation of the desired product (ABREU, 2015; LOPES, 2016).

As mentioned earlier, additive manufacturing is an important technology in the development phase of the product. Its benefits are (LOPES, 2016): less time in the product development phase, lower costs, possibility of performing several tests and prototypes, increase product complexity without increasing deadline, decrease in

project delivery time.

1.1 Historic

The first known 3D printer was invented and patented by Charles W. Hull in 1986. In his patent he describes a method where it is possible to fabricate objects by solidifying layers of a photo polymer (resin). This process was called stereolithography (ABREU, 2015, AGUIAR, 2014).

Three years later, in 1989, Scott Crump patented another 3D printing equipment that uses a different method than the Charles Hull printer, called Fused Deposition Modelling (FDM). Through the ability to move along three axes, the nozzle of the printer deposits a molten material, and layer by layer the final object is produced. (AGUIAR, 2014).

However, the rapid prototyping process became better known and accessible in the early 2000s. With the expiration of FDM patents, Adrian Bowyer created the RepRap (Replicating Rapid Prototyper), where the software of the equipment is free, its source code is open and 57% of the mechanical 3D printer components are manufactured through the additive manufacturing process (concept of self-replicating machine). In this way, in 2004 the first low-cost 3D printer appeared (ABREU, 2015).

By having an open system, many people were interested in developing and enhancing Adrian Bowyer's original design, and thus, the 3D printer has become cheaper, more accessible and more efficient (ABREU, 2015).

1.2 Different Types of 3D Printing

Over the years, the evolution of technology has had a major impact on the development of other 3D printing processes. The following are the most applied processes.

1.2.1 Stereolithography (SLA)

As previously mentioned, stereolithography was the first 3D printing process created and, according to Abreu (2015), is the most used type of additive manufacture.

By means of the incidence of an ultraviolet laser, a layer of liquid resin is solidified. After this step, the platform where the solidified resin layer is located is moved slightly downward, causing a layer of liquid resin to be added. Again, the laser solidifies the resin creating a second layer. This process is repeated until the object is completely constructed (ABREU, 2015; LOPES, 2016; BIKAS et al., 2016).

1.2.2 Fused Deposition Modelling (FDM)

As explained earlier, the FDM process was the second type of additive manufacture created and is one of the most used processes because of its low cost.

In this process, thermoplastic filaments are heated in the extruder and deposited on the construction platform by means of the extrusion nozzle. The construction platform has a lower temperature than the deposited thermoplastic, causing it to solidify rapidly. The platform moves down, and the nozzle of the extruder deposits the second layer of material. This process is repeated until the object is created. (ABREU, 2015; LOPES, 2016; BIKAS et al., 2016).

1.2.3 3DP

Unlike the processes mentioned above, the 3DP uses as a raw material a ceramic powder and a liquid binding agent. In the first step, a layer of ceramic powder is evenly distributed on the building surface. Subsequently, the liquid binding agent is applied over the desired area by means of a jet. In the third step, a piston recedes, causing the object's construction surface to move downwards. Thereafter, a new layer of ceramic powder is added, followed by the liquid binder. This procedure is repeated until the piece reaches its final shape. The piece is removed from the machine and a jet of compressed air is applied in order to remove uncoated powder from the model. The prototypes manufactured using the 3DP method are fragile, and to make them more rigid it is necessary to subject them to a process of infiltration of resins (ABREU, 2015; BIKAS et al., 2016).

1.2.4 Selective Laser Sintering (SLS)

Like the 3DP process, selective laser sintering also uses a powder (usually thermoplastic, nylon or metal) as the raw material. This material is arranged in a homogeneous layer and a laser is applied to melt its particles, and thus solidify the material. This procedure is performed many times until the part is ready (LOPES, 2016; BIKAS et al., 2016).

1.2.5 Laminated Object Manufacturing (LOM)

This process can use different types of raw material, such as paper, plastic or metal. The material is laminated by a heated roller and glued to the bottom layer. Thereafter, it is cut by means of a laser (LOPES, 2016; BIKAS et al., 2016).

1.3 Steps of 3D Printing

To develop a project via 3D printing, you need to perform the following steps (AZEVEDO, 2013; OLIVEIRA, 2016):

- Develop a project of the desired object in 3D CAD software, such as SolidWorks, Inventor, AutoCAD, among others;
- Convert the project to STL (Standard Tecelation Language) format. This format describes surfaces of an object through a set of triangles of different dimensions. The more triangles there are, the greater the project accuracy;
- The next step is to choose a reference plane from the STL file, and so the object will be divided into layers parallel to the chosen reference plane. The smaller the size of the layer, the more accurate the print will be;
- Each of these layers is described by a file called GCODE. This code has the numerical commands for the manufacture of each of the layers, possessing information of temperature, trajectory, speed, positioning, among others;
- Finally, printing is done using the GCODE code, which directs the printer to obtain the desired object.

1.4 Application

Today, rapid prototyping has a very broad reach. It can be used in the most different industries, institutions of education from the fundamental level up to the higher level and for private use (individuals).

1.4.1 Aerospace Industry

It was one of the first areas to use the benefits of 3D printing to create prototypes quickly. The components of the aviation industry have a complex geometry and use advanced materials (advanced metal alloys such as:

titanium, nickel superalloys and special steels), which makes additive manufacturing a viable option (LOPES, 2016; BAHNINI et al.,2018).

1.4.2 Car Industry

The automotive industry was also one of the first to use 3D printing for the rapid development of prototypes / products and then began using the technology to manufacture the parts used in cars. Braking systems, drive shafts and gearbox parts are some examples of parts that are manufactured through additive manufacture (LOPES, 2016; BAHNINI et al.,2018).

1.4.3 Medicine and Dentistry

Like the two sectors mentioned above, the health area was also one of the first to use the technology. 3D printing is a great way to manufacture prostheses and implants, as these products require a high degree of customization due to the different morphological characteristics of each patient (LOPES, 2016; BAHNINI et al.,2018).

The next step in 3D printing that will revolutionize the medical world is 3D bioprinting, where the goal is to create bones, tissues and living organs (LOPES, 2016; BAHNINI et al.,2018).

1.4.4 Art and Fashion

Artistic class and fashion also surrendered to the benefits of 3D printing. Plastic artists have found an easier and more direct way of bringing their ideas to life, while fashion designers use technology to create a variety of different accessories, such as: luggage, shoes, glasses and hats (LOPES, 2016).

1.5 Objective

The objective of this work is to review, analyse and classify the research carried out on 3D printing between the years 2014 and 2018. Thus, it is expected to understand in what way the researches are being carried

out and what are the results achieved on the subject in recent years.

1.6 Justification

3D printing has great potential to positively impact manufacturing processes in the industrial sector. In this way, I believe that it is important that an analysis be done on the researches being carried out on the subject, showing their advances, benefits and points to be improved.

II. METHODOLOGY

This chapter presents the two methods used to perform this work: journal selection, which describes the criteria for choosing periodicals and articles used; and classification of articles, which explains the 9 categories created to classify the selected articles.

2.1 Journals Selection

Through the CAPES Sucupira platform, a first search was made about periodicals from Engineering III (which is composed of Mechanical, Production, Aerospace and Naval). The other criterion used in the search was the relevance index, where we searched for the best articles in this question (in this case, the best articles are classified with the indexes A1, A2, B1 or B2). In this way, 21 journals were selected that had articles on Production and Manufacturing Engineering.

Using the keywords "3d printing" and "Project", searches were carried out in the 21 selected journals from 2014 to 2018. Thus, articles were found in 8 newspapers.

After analysing the selected articles, it was verified that some of them contained only brief quotations on the subject of rapid prototyping and therefore were discarded. Thus, the final selection is shown in Table 1.

Table 1: Number of articles selected after review

REL.	Nº	JOURNAL	2014	2015	2016	2017	2018	TOTAL
	1	EUROPEAN JOURNAL OF OPERATIONAL RESEARCH		0	0	0	0	1
	2	INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT		0	0	0	0	1
A1	3	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS		1	1	0	2	7
	4	JOURNAL OF ENGINEERING DESIGN		0	0	1	1	2
	5	CONCURRENT ENGINEERING: RESEARCH AND APPLICATIONS		0	1	1	0	0

	6	INTERNATIONAL JOURNAL, ADVANCED MANUFACTURING TECHNOLOGY	2	5	14	19	26	66
B1	7	INTERNATIONAL JOURNAL OF COMPUTER INTEGRATED MANUFACTURING	0	0	0	1	4	5
	8	JOURNAL OF MANUFACTURING PROCESSES	1	4	5	9	15	34
	TOTAL		4	11	31	32	56	124

2.2 Articles Selection

The 124 selected articles were classified into 9 categories: study types, affiliation, approach, study origin, geographic coverage, unit of analysis, scope, benefits and negative points.

The category "types of study" refers to the way in which research is approached. Following the classification of Miguel (2007), the main types of research approach are:

- Conceptual theorist: new theories are developed through discussions of the existing literature;
- Case study: it is a more detailed analysis of one or more subjects or objects, aiming at their greater knowledge;
- Survey: Through a survey, you get information about a problem or object. Subsequently, an analysis of the collected data is made, in order to find a solution to the problem;
- Modelling and simulation: mathematical techniques or computer software are used to better understand a system;
- Action research: it is an empirical research where the researchers and interviewees seek to solve a given problem together;
- Literature review: study on a certain area of existing literature whose objective is to know and follow its development;
- Experimental research: it is the study about a system or object, where the researcher has control of one or more variables, manipulating them to observe what happens. The second category, "affiliation", aims to show what kind of institution is behind the research: university, research center or industry. The "approach" category analyses the data format used in the research: quantitative or qualitative. Next, the categories "origin of the study" and "geographic scope" are analysed, where they cover, respectively, in which continent the research was carried out and the scope of this study (regional, national or international). The sixth category is the "unit of analysis", where the area in which the study was carried out is classified:

Application in companies or academic projects in the areas of costs, design, production or product quality; study of theoretical model; social impact; equipment (hardware, software or process).

The seventh category, "scope", contemplates the subject studied by the article, while the last two categories classify the "benefits" and "negative points" found by the researchers.

In Annex I, you will find all the classifications mentioned above, as well as their captions. In Annex II, the classifications of the 124 analysed articles are detailed, according to the captions in the tables in Annex I.

III. RESULTS AND DISCUSSION

In this chapter the results obtained will be shown and analysed in the last section of the chapter. Firstly, the data of the publication numbers of the articles selected between the years 2014 and 2018 will be shown. After that, the data of each of the 9 categories mentioned in the methodology will be shown. In the final item, the results will be discussed.

3.1 Number of Article Publications about 3D Printing

Fig. 1 shows the percentage of articles published in the selected journals between the years 2014 and 2018. The small number of articles on rapid prototyping in the years 2014 and 2015 can be perceived, with the increase of these numbers in the following years, year of 2018, with 41.79% of articles released.

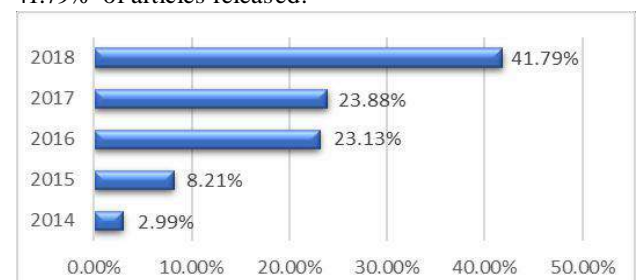


Fig. 1: Percentage distribution of articles published per year.

3.2 Types of Study

Fig. 2 shows the distribution of the types of studies performed. It was verified that the research study of the case was the most accomplished, with 61.3%. It is followed by far by experimental research, with 22.6%. Literature review, action research, modelling and simulation, survey and conceptual theorist obtained less than 10%, and action research was not performed once.

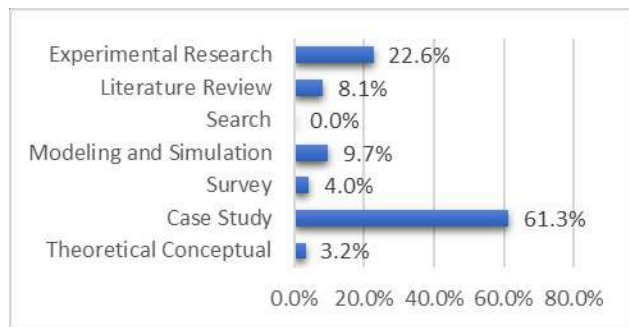


Fig. 2: Classification by type of study performed.

3.3 Affiliation

In order to carry out this classification, only the main author of each article was considered. Thus, although there were contributions from individuals linked to private industries and research centers, it was considered that 100% of the articles were carried out through universities, due to the fact that all the leaders of the articles are linked to institutions of teaching.

3.4 Approach

Fig. 3 shows the type of approach performed in the selected works, being it quantitative or qualitative. According to the figure below, 79.8% of the cases adopted are quantitative.

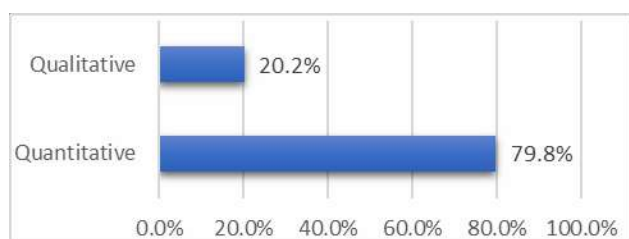


Fig. 3: Classification by approach.

3.5 Origin of Study

Fig. 4 classifies the origin of the articles. Asia and Europe lead the number of publications with 32.3% each. While the countries of the Americas (the only countries cited were the United States and Canada) published 25.8%. Oceania and Africa reached 4.8% and 2.4%, respectively, while Brazil also published 2.4% of the articles.

Even if the comparison between Brazil versus whole continents is somewhat unfair, the ideal would be that the number of relevant Brazilian research in the international scenario will grow in the coming years.

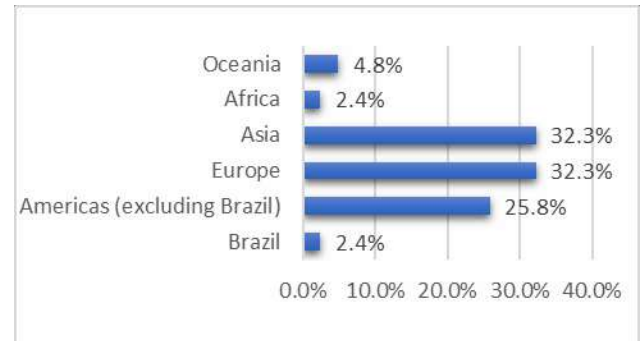


Fig. 4: Classification by origin

3.6 Geographical Scope

Fig. 5 classifies the articles by means of the geographical scope of the articles, that is, what territory was taken into account in their research (regional, national or international level). Only 11 of the 124 selected articles were found, and in 63.6% of these 11 articles, they were classified as international coverage and the other 36.6% as a national coverage.

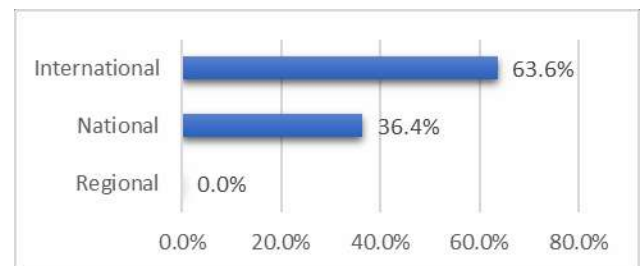


Fig. 5: Classification by geographic scope.

3.7 Unit of Analysis

Fig. 6 shows the unit of analysis data, that is, the area in which the search was performed. They were classified into 5 main groups, 4 of which have subgroups:

- Improvement in fast prototyping equipment (53.2%), being subdivided into process (33.1%), hardware (4.8%) and software (15.3%);
- Application in academic projects (37%), being subdivided into product quality (18.5%), production (11.3%), design (5.6%) and costs (1.6%);
- Application in companies (29.1%), being subdivided into product quality (3.2%), production (12.1%), design (6.5%) and costs (7.3%);
- Social Impact (1.6%), being subdivided into education (0%) and environmental (1.6%);
- Study of theoretical model (5.3%).

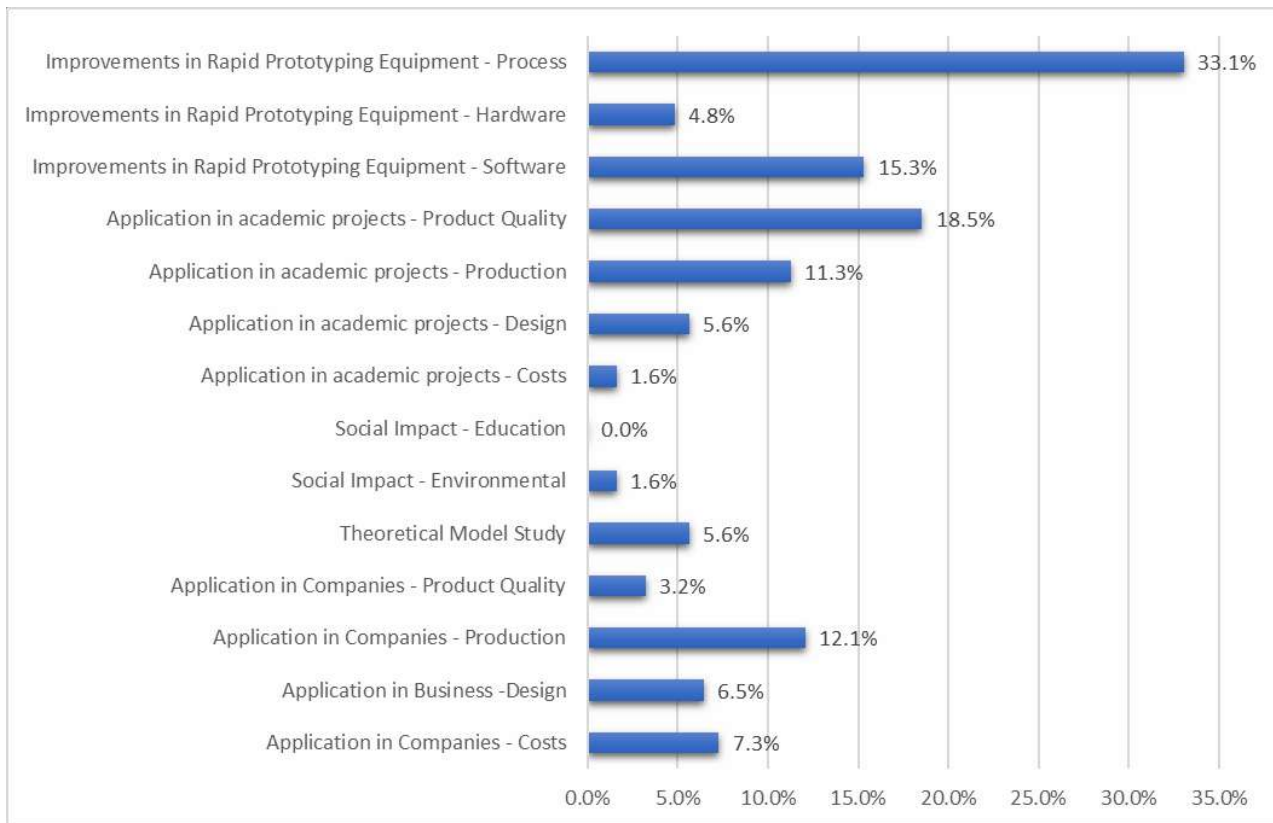


Fig. 6: Classification by unit of analysis.

3.8 Scope

Fig. 7 shows the scoped classification of articles. 62.1% of the articles refer to product development (it was considered as product development: manufacture of parts

via additive manufacture and improvements related to the "product" 3D printer), followed by a 21.8% impact of rapid prototyping and 12.1% to implementation strategies. The other items have less than 10%.

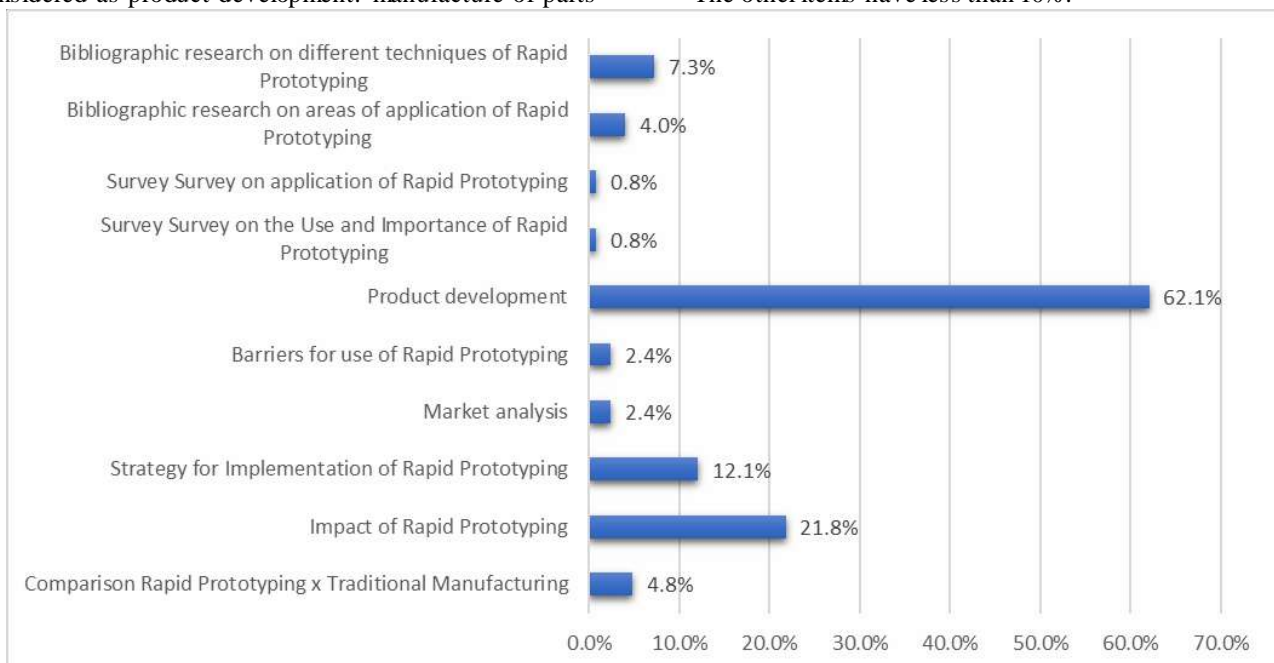


Fig. 7: Scope classification.

3.9 Benefits

Fig. 8 shows the benefits that rapid prototyping can provide. Of the 124 articles selected, 73 of them have verified one or more contributions. The contributions were classified into 8 different types, and the item "higher quality" appears in 38.7% of the articles. Improved

design, lead-time reduction and lower cost represent 16.9%, 14.5% and 12.1% respectively. The benefits of flexible manufacturing process, lower material waste, lower environmental impact and increased product life span appear with less than 5% each.

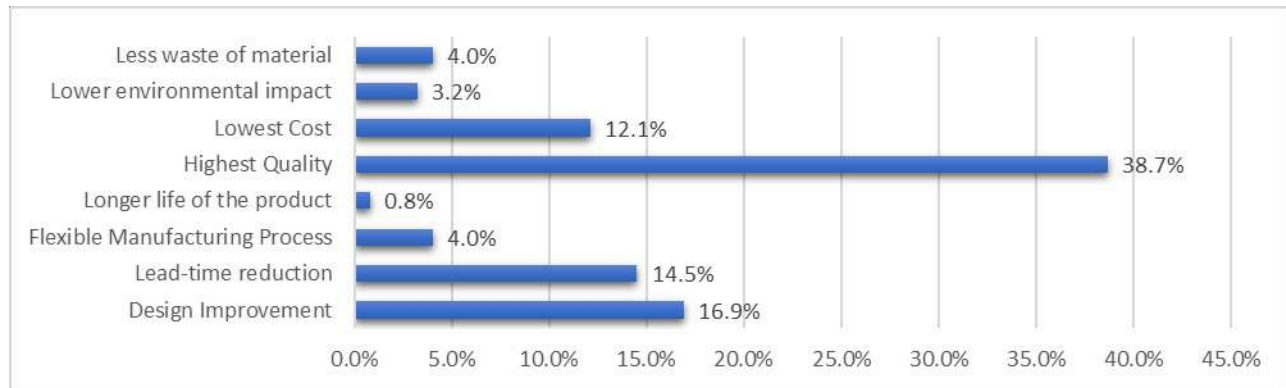


Fig. 8: Classification by benefits.

3.10 Pontos Negativos

Fig. 9 shows the negatives of rapid prototyping. Of the 124 articles selected, only 13 of them pointed out at least 1 item to improve. The highlights are the items higher

cost and difficulty of large-scale production, with 30.8% each and the items limited raw material and low reliability/quality of the product with 23.1% each.

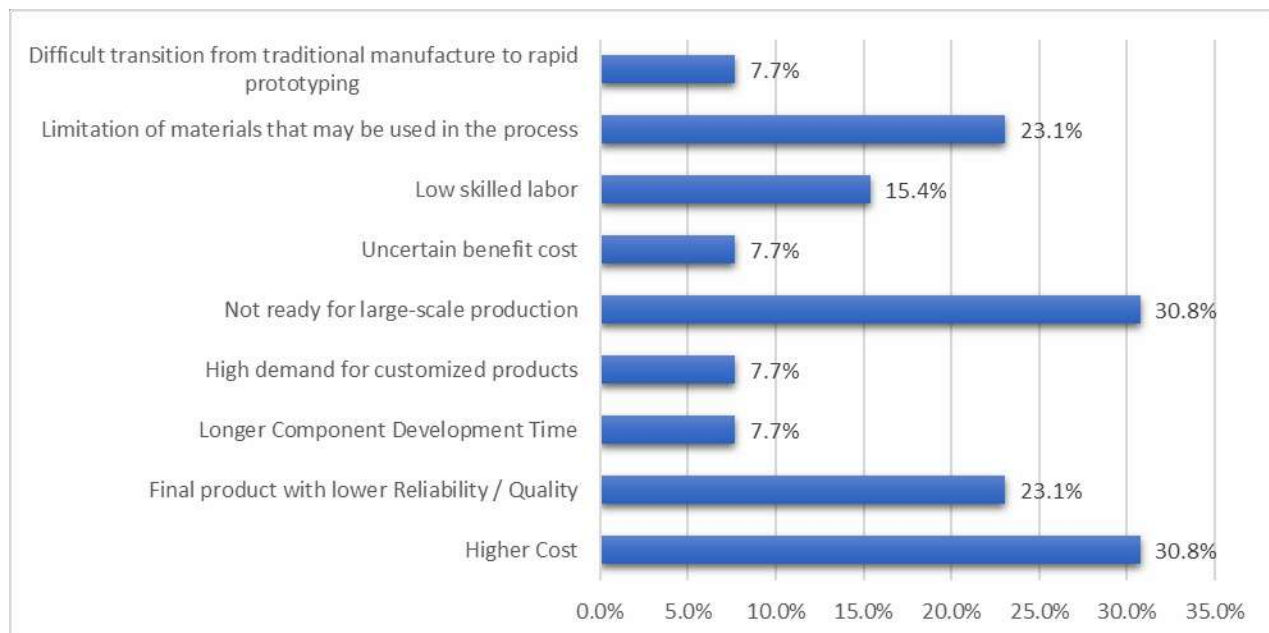


Fig. 9: Classification by negative points.

3.11 Data Analysis

Levando em consideração os dados apresentados nos itens anteriores pode-se dizer que:

1. The number of surveys with a high degree of relevance on 3D printing has been increasing year after year. This indicates that the theme's importance and

popularity have been growing and are seeking new ways to improve technology;

2. Although some studies are conducted exclusively for the purpose of studying the market or solving problems of private initiative, it is universities that conduct research in this area;

3. Europe and Asia are the continents that have published articles with a high degree of relevance about additive manufacturing;
4. Case study and experimental research were the two types of studies most performed within the analysed article sampling;
5. About 50% of articles aim to contribute to the improvement in 3D printing equipment (software, hardware or process), however, there are few articles related to the theme related to social impact;
6. 60% of the articles selected have as scope the development of a product;
7. Of the 124 papers analysed, 73 of them observed some benefit that 3D printing provided, being that higher quality, better design, reduction of lead-time and lower cost, were the qualities most cited. Meanwhile, only 13 articles mentioned some negative point regarding the additive manufacture, being lack of preparation for large- scale production and higher cost the two most cited damages.

IV. CONCLUSION

Through the data analysed, it can be concluded that 3D printing is increasingly being studied, which indicates the importance and popularity of the theme. Of the 124 articles selected, 2.99% of them were published in 2014, 8.21% in 2015, 23.13% in 2016, 23.88% in 2017 and 41.79% in 2018. Taking into account the category affiliation, all articles were classified as university students, that is, the research was led by professionals linked to higher education institutions. Taking into account the origin of the articles produced, it was verified that the majority are from Asia and Europe (32.2% produced in each continent, totalling 64.4%). Regarding the unit of analysis, the highlight was the improvement of equipment with a focus on process (33.1%) and, in article scope, the product development item was the most cited (62.1%). Finally, in the categories of benefits and negatives of 3D printing, the highlights were the higher quality of the product (38.7%) and higher cost and lack of capacity for high-scale production, with 30.8% for each of the items.

REFERENCES

- [1] ABREU, Sofia Alexandra Chaves. Impressão 3D Baixo Custo Versus Impressão em Equipamentos de Elevado Custo. 2015. 235 p. 2015. Dissertação (Mestrado Integrado em Engenharia Mecânica), Faculdade de Engenharia, Universidade do Porto, 2015.
- [2] AGUIAR, Leonardo de Conti Dias; YONEZAW, W. M. Construção de instrumentos didáticos com impressoras 3D. IV Simpósio Nacional de Ensino de Ciência e

Tecnologia (SINECT), Ponta Grossa, PR, Brasil, 2014.

- [3] ALABOODI, Abdulaziz S.; SIVASANKARAN, S. Experimental design and investigation on the mechanical behavior of novel 3D printed biocompatibility polycarbonate scaffolds for medical applications. *Journal of Manufacturing Processes*, v. 35, p. 479-491, 2018.
- [4] ALBERTI, E. A.; BUENO, B. M. P.; D'OLIVEIRA, A. S. C. M. Additive manufacturing using plasma transferred arc. *The International Journal of Advanced Manufacturing Technology*, v. 83, n. 9-12, p. 1861-1871, 2016.
- [5] ALLI, M Hazrat; MIR-NASIRI, Nazim; KO, Wai Lun. Multi-nozzle extrusion system for 3D printer and its control mechanism. *The International Journal of Advanced Manufacturing Technology*, v. 86, n. 1-4, p. 999-1010, 2016.
- [6] AREIR, Milad et al. A study of 3D printed active carbon electrode for the manufacture of electric double-layer capacitors. *Journal of Manufacturing Processes*, v. 25, p. 351-356, 2017.
- [7] ASADOLLAHI-YAZDI, Elnaz; GARDAN, Julien; LAFON, Pascal. Toward integrated design of additive manufacturing through a process development model and multi-objective optimization. *The International Journal of Advanced Manufacturing Technology*, v. 96, n. 9-12, p. 4145-4164, 2018.
- [8] AZEVEDO, Fábio Mariotto de. Estudo e projeto de melhoria em máquina de impressão 3D. 2013. 48f. Trabalho de Conclusão de Curso – Escola de Engenharia de São Carlos, Universidade de São Paulo, São Carlos, 2013.
- [9] BAHNINI, Insaf et al. Additive manufacturing technology: the status, applications, and prospects. *The International Journal of Advanced Manufacturing Technology*, p. 1-15, 2018.
- [10] BATURYNSKA, Ivanna. Statistical analysis of dimensional accuracy in additive manufacturing considering STL model properties. *The International Journal of Advanced Manufacturing Technology*, p. 1-15, 2018.
- [11] BAUMANN, Felix W.; KOPP, Oliver; ROLLER, Dieter. Abstract API for 3D printing hardware and software resources. *The International Journal of Advanced Manufacturing Technology*, v. 92, n. 1-4, p. 1519-1535, 2017.
- [12] BIKAS, H.; STAVROPOULOS, Panagiotis; CHRYSSOLOURIS, George. Additive manufacturing methods and modelling approaches: a critical review. *The International Journal of Advanced Manufacturing Technology*, v. 83, n. 1-4, p. 389-405, 2016.
- [13] BONNARD, Renan et al. STEP-NC digital thread for additive manufacturing: data model, implementation and validation. *International Journal of Computer Integrated Manufacturing*, v. 31, n. 11, p. 1141-1160, 2018.

- [14] BOURNIAS-VAROTSIS, Alkaios et al. Ultrasonic Additive Manufacturing as a form-then-bond process for embedding electronic circuitry into a metal matrix. *Journal of Manufacturing Processes*, v. 32, p. 664-675, 2018.
- [15] BRANT, Anne; SUNDARAM, Murali M. A novel system for cloud-based micro additive manufacturing of metal structures. *Journal of Manufacturing Processes*, v. 20, p. 478-484, 2015.
- [16] BROOKS, Byron James et al. Robot-assisted 3D printing of biopolymer thin shells. *The International Journal of Advanced Manufacturing Technology*, v. 89, n. 1-4, p. 957-968, 2017.
- [17] BRUNA-ROSSO, Claire et al. Global sensitivity analyses of a selective laser melting finite element model: influential parameters identification. *The International Journal of Advanced Manufacturing Technology*, v. 99, n. 1-4, p. 833-843, 2018.
- [18] CAVIGGIOLI, Federico; UGHETTO, Elisa. A bibliometric analysis of the research dealing with the impact of Additive Manufacturing on industry, business and society. *International Journal of Production Economics*, 2018.
- [19] CHEKUROV, Sergei et al. The perceived value of additively manufactured digital spare parts in industry: An empirical investigation. *International Journal of Production Economics*, v. 205, p. 87-97, 2018.
- [20] CHAI, Yuan et al. Laser polishing of thermoplastics fabricated using fused deposition modelling. *The International Journal of Advanced Manufacturing Technology*, p. 1-8, 2018.
- [21] CHAN, Hing Kai et al. The impact of 3D Printing Technology on the supply chain: Manufacturing and legal perspectives. *International Journal of Production Economics*, v. 205, p. 156-162, 2018.
- [22] CHARRO, Alberto; SCHAEFER, Dirk. Cloud Manufacturing as a new type of Product-Service System. *International Journal of Computer Integrated Manufacturing*, v. 31, n. 10, p. 1018-1033, 2018.
- [23] CHEN, Lian et al. The research status and development trend of additive manufacturing technology. *The International Journal of Advanced Manufacturing Technology*, v. 89, n. 9-12, p. 3651-3660, 2017.
- [24] CHONG, Li; RAMAKRISHNA, Seeram; SINGH, Sunpreet. A review of digital manufacturing-based hybrid additive manufacturing processes. *The International Journal of Advanced Manufacturing Technology*, v. 95, n. 5-8, p. 2281-2300, 2018.
- [25] CORREA, Jorge E. et al. Laminated micro-machine: Design and fabrication of a flexure-based Delta robot. *Journal of Manufacturing Processes*, v. 24, p. 370-375, 2016.
- [26] DAWOUD, Michael; TAHA, Iman; EBEID, Samy J. Mechanical behaviour of ABS: An experimental study using FDM and injection moulding techniques. *Journal of Manufacturing Processes*, v. 21, p. 39-45, 2016.
- [27] DAWOUD, Michael; TAHA, Iman; EBEID, Samy J. Strain sensing behaviour of 3D printed carbon black filled ABS. *Journal of Manufacturing Processes*, v. 35, p. 337-342, 2018.
- [28] DE BLAS ROMERO, Adrián et al. Lithography- based additive manufacture of ceramic biodevices with design-controlled surface topographies. *The International Journal of Advanced Manufacturing Technology*, v. 88, n. 5-8, p. 1547-1555, 2017.
- [29] DU, Zhenglin et al. Investigation of porosity reduction, microstructure and mechanical properties for joining of selective laser melting fabricated aluminium composite via friction stir welding. *Journal of Manufacturing Processes*, v. 36, p. 33-43, 2018.
- [30] DUTY, Chad et al. What makes a material printable? A viscoelastic model for extrusion-based 3D printing of polymers. *Journal of Manufacturing Processes*, v. 35, p. 526-537, 2018.
- [31] ESPALIN, David et al. 3D Printing multifunctionality: structures with electronics. *The International Journal of Advanced Manufacturing Technology*, v. 72, n. 5-8, p. 963-978, 2014.
- [32] ESTELLE, Kevin et al. Manufacturing of smart composites with hyperelastic property gradients and shape memory using fused deposition. *Journal of Manufacturing Processes*, v. 28, p. 500-507, 2017.
- [33] EYERS, Daniel R. et al. The flexibility of industrial additive manufacturing systems. *International Journal of Operations & Production Management*, v. 38, n. 12, p. 2313-2343, 2018.
- [34] FANG, Xuewei et al. An investigation on effects of process parameters in fused-coating based metal additive manufacturing. *Journal of Manufacturing Processes*, v. 28, p. 383-389, 2017.
- [35] FENG, Qixiang et al. Quasi-static analysis of mechanical properties of Ti6Al4V lattice structures manufactured using selective laser melting. *The International Journal of Advanced Manufacturing Technology*, v. 94, n. 5-8, p. 2301-2313, 2018.
- [36] FERREIRA, Arno et al. Retrofitment, open-sourcing, and characterisation of a legacy fused deposition modelling system. *The International Journal of Advanced Manufacturing Technology*, v. 90, n. 9-12, p. 3357-3367, 2017.
- [37] GARG, Akhil et al. A comprehensive study in quantification of response characteristics of incremental sheet forming process. *The International Journal of Advanced Manufacturing Technology*, v. 89, n. 5-8, p. 1353-1365, 2017.
- [38] GHOBADIAN, Abby et al. Examining legitimatisation of additive manufacturing in the interplay between innovation, lean manufacturing and sustainability. *International Journal of Production Economics*, 2018.
- [39] GOH, Guo Liang et al. Additively manufactured multi-material free-form structure with printed electronics. *The International Journal of Advanced Manufacturing Technology*, v. 94, n. 1-4, p. 1309-

- 1316, 2018.
- [40] GUO, Liang; QIU, Jingxiong. Combination of cloud manufacturing and 3D printing: research progress and prospect. *The International Journal of Advanced Manufacturing Technology*, v. 96, n. 5-8, p. 1929-1942, 2018.
- [41] HABIB, Md Ahasan; KHODA, Bashir. Support grain architecture design for additive manufacturing. *Journal of Manufacturing Processes*, v. 29, p. 332-342, 2017.
- [42] HAN, Yiwei; WEI, Chuang; DONG, Jingyan. Droplet formation and settlement of phase-change ink in high resolution electrohydrodynamic (EHD) 3D printing. *Journal of Manufacturing Processes*, v. 20, p. 485-491, 2015.
- [43] HARTL, Richard F.; KORT, Peter M. Possible market entry of a firm with an additive manufacturing technology. *International Journal of Production Economics*, v. 194, p. 190-199, 2017.
- [44] HAWALDAR, Nishant; ZHANG, Jing. A comparative study of fabrication of sand casting mold using additive manufacturing and conventional process. *The International Journal of Advanced Manufacturing Technology*, v. 97, n. 1-4, p. 1037- 1045, 2018.
- [45] HELOU, Mark; KARA, Sami. Design, analysis and manufacturing of lattice structures: an overview. *International Journal of Computer Integrated Manufacturing*, v. 31, n. 3, p. 243-261, 2018.
- [46] HOLT, Nicholas et al. Microheater array powder sintering: A novel additive manufacturing process. *Journal of Manufacturing Processes*, v. 31, p. 536-551, 2018.
- [47] HSU, H. J. et al. Shrinkage prediction using finite element analysis and experimental validation using three-dimension slurry printing system. *The International Journal of Advanced Manufacturing Technology*, v. 91, n. 1-4, p. 1289-1296, 2017.
- [48] IMERI, A. et al. Fatigue analysis of the fiber reinforced additively manufactured objects. *The International Journal of Advanced Manufacturing Technology*, v. 98, n. 9-12, p. 2717-2724, 2018.
- [49] ISLAM, Mohammad Nazrul; GOMER, Hayden; SACKS, Samuel. Comparison of dimensional accuracies of stereolithography and powder binder printing. *The International Journal of Advanced Manufacturing Technology*, v. 88, n. 9-12, p. 3077-3087, 2017.
- [50] JABBARI, Amin; ABRINIA, Karen. Developing thixo-extrusion process for additive manufacturing of metals in semi-solid state. *Journal of Manufacturing Processes*, v. 35, p. 664-671, 2018.
- [51] JAISWAL, Prakhar; PATEL, Jayankumar; RAI, Rahul. Build orientation optimization for additive manufacturing of functionally graded material objects. *The International Journal of Advanced Manufacturing Technology*, p. 1-13, 2018.
- [52] JIANG, Zheng-Long et al. Multi-objective optimization of process parameters for biological 3D printing composite forming based on SNR and grey correlation degree. *The International Journal of Advanced Manufacturing Technology*, v. 80, n. 1-4, p. 549-554, 2015.
- [53] JIN, Jie; CHEN, Yong. Highly removable water support for Stereolithography. *Journal of Manufacturing Processes*, v. 28, p. 541-549, 2017.
- [54] JIN, Jie et al. A vibration-assisted method to reduce separation force for stereolithography. *Journal of Manufacturing Processes*, 2018.
- [55] JIN, Yuan; HE, Yong; DU, Jianke. A novel path planning methodology for extrusion-based additive manufacturing of thin-walled parts. *International Journal of Computer Integrated Manufacturing*, v. 30, n. 12, p. 1301-1315, 2017.
- [56] JIN, Yuan et al. An optimization approach for path planning of high-quality and uniform additive manufacturing. *The International Journal of Advanced Manufacturing Technology*, v. 92, n. 1-4, p. 651-662, 2017.
- [57] KAMATH, Chandrika. Data mining and statistical inference in selective laser melting. *The International Journal of Advanced Manufacturing Technology*, v. 86, n. 5-8, p. 1659-1677, 2016.
- [58] KANTAROS, Antreas; CHATZIDAI, Nikolaeta; KARALEKAS, Dimitris. 3D printing-assisted design of scaffold structures. *The International Journal of Advanced Manufacturing Technology*, v. 82, n. 1-4, p. 559-571, 2016.
- [59] KIM, Dong Sung Danny; TAI, Bruce L. Hydrostatic support-free fabrication of three-dimensional soft structures. *Journal of Manufacturing Processes*, v. 24, p. 391-396, 2016.
- [60] KITAYAMA, Satoshi et al. Numerical optimization of process parameters in plastic injection molding for minimizing weldlines and clamping force using conformal cooling channel. *Journal of Manufacturing Processes*, v. 32, p. 782-790, 2018.
- [61] KHODABAKHSHI, F.; GERLICH, A. P. Potentials and strategies of solid-state additive friction-stir manufacturing technology: A critical review. *Journal of Manufacturing Processes*, v. 36, p. 77-92, 2018.
- [62] KHORASANI, Amir Mahyar et al. A comprehensive study on surface quality in 5-axis milling of SLM Ti- 6Al-4V spherical components. *The International Journal of Advanced Manufacturing Technology*, v. 94, n. 9-12, p. 3765-3784, 2018.
- [63] KNOFIUS, Nils; VAN DER HEIJDEN, Matthijs C.; ZIJM, Willem HM. Consolidating spare parts for asset maintenance with additive manufacturing. *International journal of production economics*, v. 208, p. 269-280, 2019.
- [64] KUMAR, Narendra et al. The effect of process parameters on tensile behavior of 3D printed flexible parts of ethylene vinyl acetate (EVA). *Journal of Manufacturing Processes*, v. 35, p. 317-326, 2018.
- [65] KUMAR, Narendra et al. Investigation on the effects of

- process parameters in CNC assisted pellet based fused layer modeling process. *Journal of Manufacturing Processes*, v. 35, p. 428-436, 2018.
- [66] KUMAR, Sanjay. Process chain development for additive manufacturing of cemented carbide. *Journal of Manufacturing Processes*, v. 34, p. 121-130, 2018.
- [67] LAPLUME, Andre; ANZALONE, Gerald C.; PEARCE, Joshua M. Open-source, self-replicating 3-D printer factory for small-business manufacturing. *The International Journal of Advanced Manufacturing Technology*, v. 85, n. 1-4, p. 633-642, 2016.
- [68] LEAL, R. et al. Additive manufacturing tooling for the automotive industry. *The International Journal of Advanced Manufacturing Technology*, v. 92, n. 5-8, p. 1671-1676, 2017.
- [69] LEBEDEV, S. M. et al. Mechanical properties of PLA-based composites for fused deposition modeling technology. *The International Journal of Advanced Manufacturing Technology*, p. 1-8, 2018.
- [70] LEE, Y. S.; NANDWANA, Peeyush; ZHANG, Wei. Dynamic simulation of powder packing structure for powder bed additive manufacturing. *The International Journal of Advanced Manufacturing Technology*, v. 96, n. 1-4, p. 1507-1520, 2018.
- [71] LEI, Ningrong et al. An additive manufacturing process model for product family design. *Journal of Engineering Design*, v. 27, n. 11, p. 751-767, 2016.
- [72] LI, Dawei et al. Interior structural optimization based on the density-variable shape modeling of 3D printed objects. *The International Journal of Advanced Manufacturing Technology*, v. 83, n. 9-12, p. 1627-1635, 2016.
- [73] LI, Dawei et al. Self-supporting interior structures modeling for buoyancy optimization of computational fabrication. *The International Journal of Advanced Manufacturing Technology*, v. 95, n. 1- 4, p. 825-834, 2018.
- [74] LI, Guiwei et al. Ultrasonic strengthening improves tensile mechanical performance of fused deposition modeling 3D printing. *The International Journal of Advanced Manufacturing Technology*, p. 1-9, 2018.
- [75] LI, Lin; HAGHIGHI, Azadeh; YANG, Yiran. A novel 6-axis hybrid additive-subtractive manufacturing process: Design and case studies. *Journal of Manufacturing Processes*, v. 33, p. 150-160, 2018.
- [76] LIU, Xinhua et al. Mechanical property parametric appraisal of fused deposition modeling parts based on the gray Taguchi method. *The International Journal of Advanced Manufacturing Technology*, v. 89, n. 5- 8, p. 2387-2397, 2017.
- [77] LIU, Yang et al. Study on the influence of process parameters on the clearance feature in non-assembly mechanism manufactured by selective laser melting. *Journal of Manufacturing Processes*, v. 27, p. 98-107, 2017.
- [78] LOCKETT, Helen et al. Design for Wire+ Arc Additive Manufacture: design rules and build orientation selection. *Journal of Engineering Design*, v. 28, n. 7-9, p. 568-598, 2017.
- [79] LOPES, Gonçalo Teixeira Ferreira. Exploração das possibilidades da impressão 2D na construção. 2015-2016. 92 f. Dissertação (Mestrado em Engenharia Civil) – Faculdade de Engenharia, Universidade do Porto, Porto, 2016.
- [80] MACDONALD, Eric et al. Fabricating patch antennas within complex dielectric structures through multi-process 3D printing. *Journal of Manufacturing Processes*, v. 34, p. 197-203, 2018.
- [81] MAI, Jingeng et al. Customized production based on distributed 3D printing services in cloud manufacturing. *The International Journal of Advanced Manufacturing Technology*, v. 84, n. 1-4, p. 71-83, 2016.
- [82] MANÇANARES, Cauê G. et al. Additive manufacturing process selection based on parts' selection criteria. *The International Journal of Advanced Manufacturing Technology*, v. 80, n. 5-8, p. 1007-1014, 2015.
- [83] MANDIL, Guillaume et al. Building new entities from existing titanium part by electron beam melting: microstructures and mechanical properties. *The International Journal of Advanced Manufacturing Technology*, v. 85, n. 5-8, p. 1835-1846, 2016.
- [84] MAO, Huachao; ZHOU, Chi; CHEN, Yong. LISA: Linear immersed sweeping accumulation. *Journal of Manufacturing Processes*, v. 24, p. 406-415, 2016.
- [85] MAWALE, Mahesh B.; KUTHE, Abhaykumar M.; DAHAKE, Sandeep W. Additive layered manufacturing: State-of-the-art applications in product innovation. *Concurrent Engineering*, v. 24, n. 1, p. 94-102, 2016.
- [86] MELLOR, Stephen; HAO, Liang; ZHANG, David. Additive manufacturing: A framework for implementation. *International Journal of Production Economics*, v. 149, p. 194-201, 2014.
- [87] MIGUEL, Paulo Augusto Cauchick et al. Estudo de caso na engenharia de produção: estruturação e recomendações para sua condução. *Revista Produção*, v. 17, n. 1, p. 216-229, 2007.
- [88] MOHIUDDIN, Mohammed Viquar et al. Experimental investigation to produce thin-walled sand casting using combination of casting simulation and additive manufacturing techniques. *The International Journal of Advanced Manufacturing Technology*, v. 90, n. 9-12, p. 3147-3157, 2017.
- [89] MONZÓN, M. D. et al. Standardization in additive manufacturing: activities carried out by international organizations and projects. *The international journal of advanced manufacturing technology*, v. 76, n. 5-8, p. 1111-1121, 2015.
- [90] MUN, Jiwon et al. Indirect additive manufacturing based casting of a periodic 3D cellular metal-flow simulation of molten aluminum alloy. *Journal of Manufacturing Processes*, v. 17, p. 28-40, 2015.
- [91] MONZÓN, M. D. et al. 4D printing: processability and

- measurement of recovery force in shape memory polymers. The International Journal of Advanced Manufacturing Technology, v. 89, n. 5-8, p. 1827-1836, 2017.
- [92] OLIVEIRA, Leopoldo Gomes de. Produção de palmilhas ortopédicas em máquina de impressão 3D voltada para o mercado de corredores de rua. 2016. 93 f. Trabalho de Conclusão de Curso – Universidade Federal do ABC, Santo André, 2016.
- [93] PANDA, Biranchi N. et al. Performance evaluation of warping characteristic of fused deposition modelling process. The International Journal of Advanced Manufacturing Technology, v. 88, n. 5-8, p. 1799-1811, 2017.
- [94] PPAZETIS, G.; VOSNIAKOS, G.-C. Direct porous structure generation of tissue engineering scaffolds for layer-based additive manufacturing. The International Journal of Advanced Manufacturing Technology, v. 86, n. 1-4, p. 871-883, 2016.
- [95] PEREIRA, S.; VAZ, A. I. F.; VICENTE, L. N. On the optimal object orientation in additive manufacturing. The International Journal of Advanced Manufacturing Technology, p. 1-10, 2018.
- [96] PIRES, Liliana Sofia Oliveira; FERNANDES, Maria Helena Figueira Vaz; DE OLIVEIRA, José Martinho Marques. Biofabrication of glass scaffolds by 3D printing for tissue engineering. The International Journal of Advanced Manufacturing Technology, v. 98, n. 9-12, p. 2665-2676, 2018.
- [97] PRADEL, Patrick et al. Investigation of design for additive manufacturing in professional design practice. Journal of Engineering Design, v. 29, n. 4-5, p. 165-200, 2018.
- [98] PRADEL, Patrick et al. A framework for mapping design for additive manufacturing knowledge for industrial and product design. Journal of Engineering Design, v. 29, n. 6, p. 291-326, 2018.
- [99] PRIMO, Teresa et al. Additive manufacturing integration with topology optimization methodology for innovative product design. The International Journal of Advanced Manufacturing Technology, v. 93, n. 1-4, p. 467-479, 2017.
- [100] RAVI, Abinash Kurapatti; DESHPANDE, Anagh; HSU, Keng H. An in-process laser localized pre-deposition heating approach to inter-layer bond strengthening in extrusion based polymer additive manufacturing. Journal of Manufacturing Processes, v. 24, p. 179-185, 2016.
- [101] RAVN, Poul Martin; GUDLAUGSSON, Tómas Vignir; MORTENSEN, Niels Henrik. A multi-layered approach to product architecture modeling: Applied to technology prototypes. Concurrent Engineering, v. 24, n. 1, p. 3-16, 2016.
- [102] SALONITIS, Konstantinos. Design for additive manufacturing based on the axiomatic design method. The International Journal of Advanced Manufacturing Technology, v. 87, n. 1-4, p. 989-996, 2016.
- [103] SASAKI, Yuhi et al. Adaptive direct slicing of volumetric attribute data represented by trivariate B-spline functions. The International Journal of Advanced Manufacturing Technology, v. 91, n. 5-8, p. 1791-1807, 2017.
- [104] SCHNIEDERJANS, Dara G. Adoption of 3D-printing technologies in manufacturing: A survey analysis. International Journal of Production Economics, v. 183, p. 287-298, 2017.
- [105] SHANGGUAN, Haolong et al. 3D-printed rib-reinforced shell sand mold for aluminum castings. The International Journal of Advanced Manufacturing Technology, p. 1-8, 2018.
- [106] SHEYDAEIAN, Esmat; TOYSERKANI, Ehsan. A system for selectively encapsulating porogens inside the layers during additive manufacturing: From conceptual design to the first prototype. Journal of Manufacturing Processes, v. 26, p. 330-338, 2017.
- [107] SINGH, Sunpreet; RAMAKRISHNA, Seeram; SINGH, Rupinder. Material issues in additive manufacturing: A review. Journal of Manufacturing Processes, v. 25, p. 185-200, 2017.
- [108] SNELLING, Dean A. et al. Binder jetting advanced ceramics for metal-ceramic composite structures. The International Journal of Advanced Manufacturing Technology, v. 92, n. 1-4, p. 531-545, 2017.
- [109] SUNNY, SM Nahian Al; LIU, Xiaoqing F.; SHAHRIAR, Md Rakib. Communication method for manufacturing services in a cyber-physical manufacturing cloud. International Journal of Computer Integrated Manufacturing, v. 31, n. 7, p. 636-652, 2018.
- [110] TANG, Shiyan et al. Layered extrusion forming—a simple and green method for additive manufacturing ceramic core. The International Journal of Advanced Manufacturing Technology, v. 96, n. 9-12, p. 3809-3819, 2018.
- [111] TAVAKOLI, Mahmoud et al. Anthropomorphic finger for grasping applications: 3D printed endoskeleton in a soft skin. The International Journal of Advanced Manufacturing Technology, v. 91, n. 5- 8, p. 2607-2620, 2017.
- [112] THOMAS-SEALE, L. E. J. et al. The barriers to the progression of additive manufacture: Perspectives from UK industry. International Journal of Production Economics, v. 198, p. 104-118, 2018.
- [113] TRONVOLL, Sigmund A.; WELO, Torgeir; ELVERUM, Christer W. The effects of voids on structural properties of fused deposition modelled parts: a probabilistic approach. The International Journal of Advanced Manufacturing Technology, p. 1-12, 2018.
- [114] UPADHYAY, Meet; SIVARUPAN, Tharmalingam; EL MANSORI, Mohamed. 3D printing for rapid sand casting—A review. Journal of Manufacturing Processes, v. 29, p. 211-220, 2017.
- [115] URBANIC, R. J.; HEDRICK, R. W.; BURFORD, C. G. A

- process planning framework and virtual representation for bead-based additive manufacturing processes. The International Journal of Advanced Manufacturing Technology, v. 90, n. 1- 4, p. 361-376, 2017.
- [116] VIJAYARAGHAVAN, Venkatesh et al. Process characterisation of 3D-printed FDM components using improved evolutionary computational approach. The International Journal of Advanced Manufacturing Technology, v. 78, n. 5-8, p. 781-793, 2015.
- [117] WANG, Di et al. Surface quality of the curved overhanging structure manufactured from 316-L stainless steel by SLM. The International Journal of Advanced Manufacturing Technology, v. 86, n. 1-4, p. 781-792, 2016.
- [118] WANG, Jia-Chang; DOMMATI, Hitesh. Fabrication of zirconia ceramic parts by using solvent-based slurry stereolithography and sintering. The International Journal of Advanced Manufacturing Technology, v. 98, n. 5-8, p. 1537- 1546, 2018.
- [119] WEI, Chuang; DONG, Jingyan. Hybrid hierarchical fabrication of three-dimensional scaffolds. Journal of Manufacturing Processes, v. 16, n. 2, p. 257-263, 2014.
- [120] WELLER, Christian; KLEER, Robin; PILLER, Frank T. Economic implications of 3D printing: Market structure models in light of additive manufacturing revisited. International Journal of Production Economics, v. 164, p. 43-56, 2015.
- [121] WESTERWEEL, Bram; BASTEN, Rob JI; VAN HOUTUM, Geert-Jan. Traditional or Additive Manufacturing? Assessing component design options through lifecycle cost analysis. European Journal of Operational Research, 2018.
- [122] XIAO, Kaida et al. Developing a 3D colour image reproduction system for additive manufacturing of facial prostheses. The International Journal of Advanced Manufacturing Technology, v. 70, n. 9-12, p. 2043-2049, 2014.
- [123] YAMAN, Ulas. Shrinkage compensation of holes via shrinkage of interior structure in FDM process. The International Journal of Advanced Manufacturing Technology, v. 94, n. 5-8, p. 2187- 2197, 2018.
- [124] YANG, Sheng; ZHAO, Yaoyao Fiona. Additive manufacturing-enabled design theory and methodology: a critical review. The International Journal of Advanced Manufacturing Technology, v. 80, n. 1-4, p. 327-342, 2015.
- [125] YANG, Yang et al. 3D printing of shape memory polymer for functional part fabrication. The International Journal of Advanced Manufacturing Technology, v. 84, n. 9-12, p. 2079-2095, 2016.
- [126] YANG, Yiran; LI, Lin. Cost modeling and analysis for Mask Image Projection Stereolithography additive manufacturing: Simultaneous production with mixed geometries. International Journal of Production Economics, v. 206, p. 146-158, 2018.
- [127] YAO, Xifan; LIN, Yingzi. Emerging manufacturing paradigm shifts for the incoming industrial revolution. The International Journal of Advanced Manufacturing Technology, v. 85, n. 5-8, p. 1665-1676, 2016.
- [128] ZHANG, Hongyu et al. Development of a path planning algorithm for reduced dimension patch printing conductive pattern on surfaces. The International Journal of Advanced Manufacturing Technology, v. 95, n. 5-8, p. 1645-1654, 2018.
- [129] ZHA, Wentao; ANAND, Sam. Geometric approaches to input file modification for part quality improvement in additive manufacturing. Journal of Manufacturing Processes, v. 20, p. 465-477, 2015.
- [130] ZHAO, Gang et al. Nonplanar slicing and path generation methods for robotic additive manufacturing. The International Journal of Advanced Manufacturing Technology, v. 96, n. 9-12, p. 3149-3159, 2018.

ANNEX I: Classification Tables for Articles

Table 1: Articles classification by types of study.

LABEL	T1 : Types of Study
A	Theoretical Conceptual
B	Case Study
C	Survey
D	Modeling and Simulation
E	Search
F	Literature Review
G	Experimental Research

Table 2: Articles classification by affiliation.

LABEL	T2: Affiliation
U	University
CP	Research Center
EP	Company

Table 3: Articles classification by approach.

LABEL	T3: Approach
A	Quantitative
B	Qualitative

Table 4: Articles classification by study origin.

LABEL	T4: Origin
BR	Brazil
AM	Americas (excluding Brazil)
EU	Europe
AS	Asia
AF	Africa
OC	Oceania

Table 5: Articles classification by geographical scope of the study.

LABEL	T5: Geographical scope of study
RE	Regional
NA	National
IN	International

Table 6: Articles classification by unit of analysis.

LABEL	T6: Analysis Unit
EC	Application in Companies - Costs
ED	Application in Business -Design
EP	Application in Companies - Production
EQ	Application in Companies - Product Quality
MT	Theoretical Model Study
ISA	Social Impact - Environmental

ISE	Social Impact - Education
UC	Application in academic projects - Costs
UD	Application in academic projects - Design
UP	Application in academic projects - Production
UQ	Application in academic projects - Product Quality
MS	Improvements in Rapid Prototyping Equipment - Software
MH	Improvements in Rapid Prototyping Equipment - Hardware
MP	Improvements in Rapid Prototyping Equipment - Process

Table 7: Articles classification by scope.

LABEL	T7: Scope of the article
A1	Comparison Rapid Prototyping x Traditional Manufacturing
A2	Impact of Rapid Prototyping
A3	Strategy for Implementation of Rapid Prototyping
A4	Market analysis
A5	Barriers for use of Rapid Prototyping
A6	Product development
A7	Survey Survey on the Use and Importance of Rapid Prototyping
A8	Survey Survey on application of Rapid Prototyping
A9	Bibliographic research on areas of application of Rapid Prototyping
A10	Bibliographic research on different techniques of Rapid Prototyping

Table 8: Articles classification by benefits.

LEGENDA	T8: Benefits
B1	Design Improvement
B2	Lead-time reduction
B3	Flexible Manufacturing Process
B4	Longer life of the product
B5	Highest Quality
B6	Lowest Cost
B7	Lower environmental impact
B8	Less waste of material

Table 9: Articles classification by negative points.

LEGENDA	T9: Negative points
C1	Higher Cost
C2	Final product with lower Reliability / Quality
C3	Longer Component Development Time
C4	High demand for customized products
C5	Not ready for large-scale production
C6	Uncertain benefit cost
C7	Low skilled labor
C8	Limitation of materials that may be used in the process
C9	Difficult transition from traditional manufacture to rapid prototyping

ANNEX II: Selected Articles Classification

Table 1: Classification of articles by type of study.

Journal	Authors	T1	T2	T3	T4	T5	T6	T7	T8	T9
1	Westerweel et al. (2018)	B	U	A	EU	IN	EC,ED,EQ	A1	B1,B2	C1,C2
2	Eyers et al. (2018)	B	U	B	EU	IN	EP	A2	B3	
3	Melor et al. (2014)	B	U	B	EU	IN	EP	A3	B2,B4	C3
3	Weller et al. (2015)	A,F	U	B	EU		MT	A2	B1,B2,B3	C4
3	Schniederjans (2017)	C	U	A	AM	NA	EC,ED,EP	A7	B2,B5	
3	Hartl & Kort (2017)	B	U	A	EU		MT	A4		
3	Chan et al. (2018)	C	U	B	AS	IN	EC,ED,EP	A8		C5
3	Thomas-Seale et al. (2018)	B,C	U	A	EU	NA	EC	A4, A5		C2,C5,C6, C7,C8
3	Ghobadian et al. (2018)	B	U	B	EU		EC,ISA	A2	B6,B7,B8	C5
3	Chekurov et al. (2018)	C	U	B	EU	NA	ED,EP,EQ	A3	B1,B2,B5,B6	
3	Knofius et al. (2018)	B	U	A	EU		ED,EP,EQ,EP	A3	B2,B5,B6	C9
3	Caviggioli & Ughetto (2018)	F	U	A	EU	IN	EC,ISA	A9		
3	Yang & Lin (2018)	D	U	A	AM		MT	A2	B1,B6	
4	Lei et al. (2016)	B	U	A	AS		UQ	A1, A2	B1	
4	Lockett et al. (2017)	B	U	A	EU		UQ	A2	B1,B8	
4	Pradel et al. (Jun, 2018)	B	U	B	EU		ED	A9		
4	Pradel et al. (Mar, 2018)	C	U	B	EU	IN	ED	A2	B1	C1
5	Ravn et al. (2015)	D	U	B	EU	NA	MS	A2	B1	
5	Mawale et al. (2016)	B	U	B	AS		EC,ED,EQ	A2	B1,B5,B6	
6	Xiao et al. (2014)	B,D,G	U	A	EU		UQ,UD,UC	A2,A6	B1,B2,B5,B6	

6	Espalin et al. (2014)	B,G	U	A	AM		UQ,UP	A2,A6	B1	
6	Monzón et al. (2015)	B	U	B	EU		EP	A3,A5		C7,C8
6	Vijayaraghavan et al. (2015)	D	U	A	AS		MS	A2	B1,B5	
6	Jiang et al. (2015)	D,G	U	A	AS		MP	A2,A6	B5	
6	Mançaneres et al. (2015)	B	U	A	BR		UQ	A2,A6		
6	Yang & Zhao (2015)	A	U	B	AM		MT	A2,A6		
6	Kantaros et al. (2016)	G	U	A	EU		MH	A6	B5	
6	Bikas et al. (2016)	F	U	B	EU		MT	A10		
6	Mai et al. (2016)	B	U	B	AS		EP	A2	B2,B3,B6,B7	
6	Li et al. (2016)	A	U	A	AS		UQ	A6	B5	
6	Alberti et al. (2016)	G	U	A	BR		MP	A2	B5	
6	Yang & Lin (2016)	G	U	A	AS		MP, UQ	A2,A6	B5	
6	Yao & Lin (2016)	B	U	B	AS		EP	A3	B3	
6	Laplume et al. (2016)	B	U	A	AM		EC, EP	A4		
6	Mandil et al. (2016)	B	U	A	EU		MP	A2	B5	
6	Ali et al. (2016)	G	U	A	AS		MH, MP	A2	B6	C5
6	Wang et al. (Set,2016)	B	U	A	AS		UQ	A6	B5	
6	Papazetis & Vosniakos (2016)	B	U	A	EU		UQ	A6	B5	
6	Kamath (2016)	G	U	A	AM		MS	A2	B5	
6	Salonitis (2016)	B	U	B	EU		UD	A3		
6	Islam et al. (2017)	B	U	A	OC		UQ	A10		
6	Romero et al. (2017)	B	U	B	EU		MP	A2,A6		
6	Panda et al. (2017)	B	U	A	EU		UQ	A10		
6	Brooks et al.	G	U	A	OC		MP	A2,A6		

	(2017)								
6	Monzón et al. (2017)	G	U	A	EU		MP	A2,A6	B1,B5
6	Liu et al. (2017)	G	U	A	AS		MP	A2,A6	B5
6	Garg et al. (2017)	G	U	A	AS		MP	A2,A6	B5
6	Chen et al. (2017)	B	U	B	AS		EP	A3,A5	C1,C8
6	Urbanic et al. (2017)	B	U	A	AM		EP	A3	
6	Ferreira et al. (2017)	G	U	A	OC		MS, MH	A6	B5
6	Mohiuddin et al. (2017)	B,D	U	A	AS		UQ	A6	B5
6	Tavakoli et al. (2017)	B	U	A	EU		UD	A6	B5
6	Hsu et al. (2017)	B,D	U	A	AS		UP, UQ	A6	B5,B6
6	Sasaki et al. (2017)	D	U	A	AS		MS	A6	
6	Baumann et al. (2017)	B	U	B	EU		UP	A3	
6	Snelling et al. (2017)	B	U	A	AM		MP	A6	B5
6	Leal et al. (2017)	B	U	A	EU	IN	EP,EC	A1,A3,A6	B2,B6
6	Jin et al. (2017)	B	U	A	AS		MS	A6	B1
6	Primo et al. (2017)	B	U	A	EU		UD,UP	A6	B5
6	Goh et al. (2018)	B	U	A	AS		UQ	A10	B5
6	Yaman (2018)	B	U	A	EU		MS,MP	A6	B5,B8
6	Feng et al. (2018)	B	U	A	AS		UP	A6	B1,B6
6	Khorasani et al. (2018)	B	U	A	OC		UD,UP	A6	B1
6	Li et al. (Mar, 2018)	B	U	A	AS		MS,MP	A6	B1,B5
6	Chong et al. (2018)	F	U	B	AS		UD,UP	A10	
6	Zhang et al. (Mar, 2018)	B	U	A	AS		MS	A6	B2
6	Lee et al. (2018)	D	U	A	AM		MP	A6	
6	Jaiswal et al.	B	U	A	AM		MS	A6	B2

	(2018)								
6	Li et al. (May, 2018)	G	U	A	AS		MP	A6	B5
6	Guo & Qiu (May, 2018)	F	U	B	AS		UP	A3	
6	Shangguan et al. (2018)	G	U	A	AS		MP	A6	B2,B5
6	Zhao et al. (2018)	B,D	U	A	AS		MS	A6	B2
6	Chai et al. (2018)	B	U	A	OC		UC,UP,UQ	A6	B2, B5, B6
6	Asadollahi-Yazdi et al. (2018)	B	U	A	EU		UP	A3,A6	
6	Tang et al. (2018)	G	U	A	AS		MP	A6	B5,B7
6	Hawaldar et al. (2018)	B	U	A	AM		UQ	A1	B2,B5,B8
6	Bahnini et al. (2018)	F	U	B	AF		EP	A1,A2,A9,A10	
6	Lebedev et al. (2018)	B	U	A	EU		MS	A6	B5
6	Baturynska (2018)	D	U	A	EU		UQ	A6	C1
6	Tronvoll et al. (2018)	B	U	A	EU		MS, UQ	A6	B5
6	Pereira et al. (2018)	B	U	A	EU		MS, UQ	A6	B5
6	Wang & Dommati (Set, 2018)	G	U	A	AS		MP	A6	B5
6	Pires et al. (2018)	G	U	A	EU		MP	A6	B5
6	Bruna-Rosso et al. (2018)	G	U	A	EU		MP	A6	B5
6	Imeri et al. (2018)	B	U	A	AM		UQ	A6	
7	Jin et al. (2017)	B	U	A	AS		MS	A6	B1,B2,B5
7	Sunny et al. (2018)	B	U	B	AM		UP	A3	
7	Helou & Kara (2018)	F	U	B	OC		UD,UP	A9	
7	Charro & Schaefer (2018)	B	U	A	EU		MP	A3	B3, B6
7	Bonnard et al. (2018)	A	U	A	BR		MS	A6	

8	Wei & Dong (2014)	B	U	A	AM		MS	A6	B5
8	Han et al. (2015)	B	U	A	AM		MP	A6	
8	Mun et al. (2015)	D	U	A	AS		MP	A6	
8	Brant & Sundaram (2015)	B	U	A	AM		MP	A3	B2
8	Zha & Anand (2015)	B	U	A	AM		MS	A6	B1,B5
8	Ravi et al. (2016)	B	U	A	AM		MP	A6	B5
8	Dawoud et al. (2016)	B	U	A	AF		UQ	A1	C2
8	Kim & Tai (2016)	B	U	A	AM		MP	A6	
8	Correa et al. (2016)	B	U	A	AM		MH	A6	
8	Mao et al. (2016)	B	U	A	AM		MP	A6	B1,B5
8	Habib & Khoda (2017)	B	U	A	AM		MP	A6	B1,B2,B5
8	Upadhyay et al. (2017)	F	U	A	EU		UP	A10	
8	Jin & Chen (2017)	B	U	A	AM		MH	A6	
8	Fang et al. (2017)	B	U	A	AS		MP	A6	B6
8	Estelle et al. (2017)	B	U	A	AM		MP	A6	B5
8	Liu et al. (2017)	B	U	A	AS		MH	A6	B5
8	Sheydaeian & Toyserkani (2017)	B,G	U	A	AM		MP	A6	
8	Areir et al. (2017)	B	U	A	EU		MP	A6	
8	Singh et al. (2017)	F	U	B	AS		MT	A9,A10	
8	Khodabakhshi & Gerlich (2018)	F	U	A	AM		MT	A10	
8	Du et al. (2018)	B	U	A	AS		MP	A6	
8	Alaboodi & Sivasankaran (2018)	B	U	A	AS		MP	A6	B5
8	Kumar et al. (2018)	B	U	A	AS		MH	A6	B5

8	Kumar et al. (2018)	B	U	A	AS		UQ	A6	
8	Dawoud et al. (2018)	B	U	A	AF		UQ	A6	

8	Jabbari & Abrinia (2018)	B,G	U	A	AS		MP	A6		
8	Duty et al. (2018)	B	U	A	AM		MP	A6		
8	Jin et al. (2018)	G	U	A	AM		MP	A6		
8	Kumar (2018)	G	U	A	AM		MP	A6		
8	MacDonald et al. (2018)	G	U	A	AM		UP	A6		
8	Li et al. (2018)	G	U	A	AM		MP	A6	B6,B7,B8	
8	Kitayama et al. (2018)	G	U	A	AS		MS	A6		
8	Bournias-Varotsis et al. (2018)	G	U	A	EU		MP	A6		
8	Holt et al. (2018)	G	U	A	AM		MP	A6		

Application of the Queue theory in the Optimization of systems of attendance in the ice Cream Shop in the city of Manaus-AM-Brazil

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Abstract— A queues through investigations of probability distributions generated and directed to the flow of customers and services to meet the demand of new customers waiting time in queues through practical ways. This work had as objective, a real reduction in the service queue of an ice cream shop. They were selected according to the specific needs of the optimization of processes, eliminating bottlenecks and processes. Some services have taken into account the peculiarities of the place, and public, having been receiving quality services and financially for the clients.

Keywords— *Theory of Queues, Process optimization, probability.*

I. INTRODUCTION

Queues are integrated into our lives, we come across them every day, they are easily found everywhere we go. Whether it's a simple trip to a supermarket, or even the time to pay for the products purchased, we will participate in queues. Queues are also visible in the production process, either awaiting the raw material to forge a particular part, or in the production line waiting for the previous processes to continue production.

Queuing theory and a mathematical subdivision of probability, which studies the creation of queues through mathematical formulations, is possible to calculate the beginning of the queue and even the sizes that will reach in the future, through existing models and mathematical formulas, it is possible to size this information so that an ideal layout can be created to meet the necessary demands of the queues.

Because the ice cream shop is a direct customer service, it has to address the employee to request the service desired, create temporary queues that directly affect the waiting time of the same, adversely affecting the process of the service to be offered; the agility in the queues appeals directly to customers, due to the fact that they expect less, waiting for that and for them time lost since it does not add anything to the process of acquiring your product.

Through data collection at peak times, it is possible to identify the main negative factors that contribute to the formation and development of the queues, with this data at hand and possible to work on effective solutions to solve the problems identified, using the numerical data of

times of queuing, customer service, and if it is possible to perceive the temporal deficit that is in the service flow, using the tools of queuing theory makes it possible to identify the data that will be necessary to supply the demand of identifying the total number of queues required and the ideal time to take the activity.

II. LITERATURE REVIEW

Even with all technological advances, companies that provide direct customer service will not be able to get out of the queues, the congestion of customers in queues for the purchase of products or services, be it invoice payments, internet or bank services, or until the use of equipment, for example a printer of papers, and a daily problem that the administration must handle, the waiting time in a queue reflects directly in the quality of the service of a certain establishment being directly connected the quality of the service offered.

The ice cream shop has a model of direct customer service, that is, all the service offered and requested to the responsible official, after the request is made the same, goes to prepare the service that was requested, that time between the request and the the queue is formed during the flow of processes, queues that do not add benefit to the process, and only cause customer dissatisfaction. The ice cream shop has a model of direct customer service, that is, all the service offered and asked the responsible official, after the request is made the same, goes to prepare the service that has been requested, this time between the request and the conclusion of the service, creates if a lead time, due to the attendance system if by

single queue, and the arrival rate is higher than the attendance rate, form the queue in the course of the flow of processes, queues that do not add benefit to the process, causing dissatisfaction to customers.

2.1 QUEUING THEORY

The queuing theory is a technical and mathematical concept that aims to minimize the queues that form in the process and services lines, through determined theories and formulas, if it is possible to realign them, consequently the correction of lost time in the waiting of the process of attendance.

According to [1], it is noticed that the waiting, in general, sensitize the client in its future behavior. A consumer dissatisfied with his waiting time may be able to give up his purchase at that time, however, he may no longer return to that establishment because of the perceived negative image. This is a difficult loss to be quantified, and if the problem persists for a long time the establishment will drop demand without discovering the reason of it.

When offering a product, it is offering a range of service, the time to complete the service is one of the most important factors, due to affect directly in the customer experience, leaving to positive or negative memory.

However, queuing theory is not only applied to people, in industries this fact often occurs, parts and products can wait for processing. As well ships may be waiting to enter the ports, and airplanes may be awaiting authorization to land [2].

According to [3], a queuing system is composed of many elements that are waiting to be serviced at a service station and that should wait until the station is available. According to [4], in the characterization of a queuing system, it is possible to highlight five basic components, the model of arrivals of the users, the service model, the number of available channels, the capacity for user service and the discipline of queue.

All queues follow parameters that can be measured which are them: clients, quantity of clients in the process; Average number of clients in queue (L_f) and arrival rate (λ); execution of care; limit of resources, be they equipment, helpers, among others; frequency of the queue; Number of service channels, average number of customers in queue (L_f); Average number of customers in the system (L); Average time the client waits in queue (W_f), average time that the client waits on the system (W).

The form of customer arrivals in a system occurs, most often at random, ie the number of customers arriving per unit time varies according to the behavior of the arrivals flow. For this, it is important to make a statistical

survey in order to verify the arrival process of the clients [3], [5].

2.2 MODEL OF SERVICE

Queue systems have varying structures, and each case requires a different analytical study. The structures can be classified as a single-queue and one-channel system, a single-queue system and multiple channels, and a complex system of queues and channels in series and in parallel [6].

The system of a queue is the simplest case of service queue, consisting of only one channel and a single queue, figure 1.

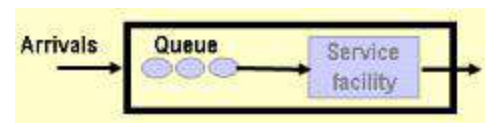


Fig.1: System single-queue and one-channel.

Source: [6].

The multi-channel system consists of multiple attendants for a single queue, thus facilitating service flow, Figure 2.

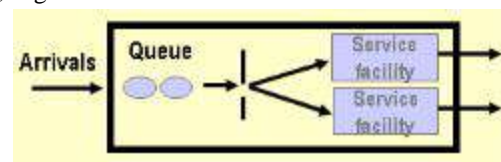


Fig.2: One queue and more than one channel.

Source:[7].

Single queues with 1 channel are the simplest and the most common ones, due to being the simplest and easiest applicable principle, however, depending on the demand in which the queue is fed, this concept must be rethought and reanalyzed in order to suppress the and provided in the queue by changing the channel quantity if it was possible to suppress the demand due to the increase in system finishing capacity.

2.3 LAYOUT

The layout also referred to as physical arrangement [8], is a graphical demonstration of the production system, although it seems to be only a system design, layout is more than that, it is a technique used to identify the locations to distribute properly the physical components of the production area, in order to organize the components in their proper places, in order to obtain the maximum possible efficiency in the production.

In order to establish exactly the layout of the production process, it is necessary to consider the location of the equipment and the employees, always aiming to be as close as possible to the process, without ignoring the process flow and the safety areas [9].

According to [8], the 3 main types of layout are: Layout by product or linear in which the product moves between the machines and the workstations, which remain

fixed. It is applicable on assembly lines. Process or functional layout is applied, for example, when products with different production flows are manufactured involving them. Fixed or positional layout in which the product remains fixed in place while machines and personnel move by performing the production tasks. This is the case of the manufacture of a ship.

An irregular layout with failures leads to a longer lead time [10], which can be improved with the alignment of the activity flow, shorter distance between equipment, less time in the process flow, which directly influences the service offered, due to the agility to carry out the process, directly influencing the reduction of queues, and customer satisfaction.

2.4 Ishikawa diagram

Known as a cause and effect diagram because it demonstrates the relationship between the possible and effects and their causes, facilitating the understanding of the problem, also known popularly as a fishbone due to its shape, the more detailed the diagram is more like a fishbone

To build the Ishikawa you must follow some steps:

- Describe the problem to be analyzed.
- Do a research on the causes to be able to elaborate the diagram, using methods like check sheet, or any other.
- Construct the diagram by specifying the problem on the right, and choose the categories of causes that will be used, such as measurement, method, people, machines, environment, materials. Or whatever you think is necessary.

Carry out the analysis of the diagram by observing the frequent causes, analyzing those that have a greater influence in the problem's appearance, thus being able to look for a plausible solution.

III. MATERIALS AND METHODS

The study was carried out in an ice cream parlor that serves the public from Monday to Sunday, from 11:00 am to 11:00 pm, with a daily workday of 8 hours per employee, which is between service preparation of the service and delivery of the service together with the payment of the customers. The ice cream shop has 1 queue and 1 service channel.

The methodology applied was as follows, a survey of the arrival and attendance times was performed, and after the queue calculations were performed, the results were used the Ishikawa diagram, whereby the main problems were identified and finally proposed new layout for optimization of the process.

3.1 USED QUEUE MODEL

In order to accurately measure the process times, searching for the solution of the queues required the

collection of the queue arrival data, queue times, and total service time.

Arrival in the queue is the number of customers arriving in a certain time interval, which can generate a probabilistic behavior, which justifies the same arrival of clients at a certain time, for example, the probability of arriving 2 clients every 30 minutes, is visually analyzed in the actual queue, by collecting the time of arrival of the clients and the interval between them, it is possible to calculate probability of arrivals of clients at a given time.

Queuing time is the time that the customer takes when arriving in the queue until being served, which takes time in the process that is very unsatisfactory for the client, and interferes directly in the customer experience, and directly influences the service time. Total time of service is the time of arrival in the queue until the exit of the system, time that appears in the actual experience of the client, sum the previous times with that of the service, and determines the actual time of the service flow, and with it is possible to analyze temporal bottlenecks, and where to improve. In order to better target the collected data and analyzed parameters it is important to map the activity flow, the current layout of the system, being able to propose new layout, and correcting the unnecessary lost times and bottlenecks presented.

The single-queue attendant system used in the system, shown in figure 3, by the design of the current layout, as it is possible to be observed, has an excess of queue causing dissatisfaction in the customers waiting on it.

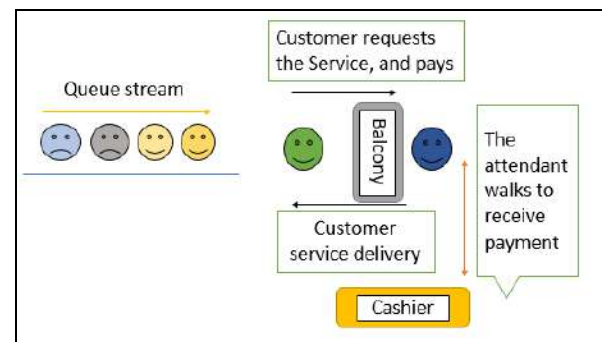


Fig.3: Current Layout

Source: author

3.2 IMPORTANCE OF THE LAYOUT

As the layout becomes old, defects begin to be visible, due to several factors, which can be an increase in productive demand, change in process, among others. These defects create bottlenecks in the layout process, creating unnecessary activities, which cause delays in the process, thus making the layout expensive, because of this it is important to modify the layout so that the current process needs can be met, because the layouts are assembled to meet a specific process, they are subject to

the process, if there is modification in the process should modify the layout, because they are in a connection and depend on each other.

By proposing a new layout in a way that harmoniously assimilates with the variation of the service channels, eliminating unnecessary activities, the system becomes leaner and more practical, being able to complete the service cycle within the necessary walls, improving the customer's final satisfaction.

IV. IMPLEMENTATION

In order to eliminate the system's needs, it was analyzed the important factors for the implementation of the suggested process through the Ishikawa diagram that made visible the main causes that directly influenced the cause of the problem, later the analysis of the current layout where unnecessary activities are observed that influence the growth of the system, generating activities more than necessary, is due to the collection of data at peak service times that demonstrates the reality of the problem, thus proving the need for change, so a new layout, which in sync with the new service process will solve the problems encountered supplying the needs of the demand, made so the practical system is lean towards customer satisfaction at the end of the process.

4.1 LAYOUT ANALYSIS

By analyzing the Ishikawa diagram, we identified the factors that were negatively influencing the queue flow, problems that were in the actual layout that was in the installed system, the factors that were hindering the process flow in the layout, was the position that was the service desk, the cashier that was located a considerable distance from the service desk, since the service and payment was done in the same operation, the employee took considerable time to go to the cashier to make the payment of the customer, unnecessary time that directly affects system time, making prolonged directly affecting the waiting customer, another observation was the lack of visible information about the variety of flavors and containers of different sizes, thus creating an increase in time due to the employee to have a dialogue with the client explaining the formats of services offered and flavors available, an explanation that could be of a visual form and the client would only have some doubt if it were necessary, since the customer would already know the service he wants, thus developing the flow of time.

4.2 IMPLEMENTATION PLANNING

Observing the errors that were explicit in the layout, the need to split the queue demand was analyzed, it was also observed that it was not necessary to create 2 queues because the space was limited and also the demand was

not so great, with the help of the mathematical calculations of operational research it was possible to verify that the minimum number of service channels to supply the demand will be of 2 channels

4.3 LAYOUT IMPLEMENTATION

The crucial part was to propose and deploy the new layout, figure 4: proposed layout, with the necessary corrections for the problems encountered, that goes from the reallocation of the freezers with the nearby box, facilitating the interactivity between the operations, and the informative signs with the flavors and types of service, facilitating the visibility of the customer, who expects to be served the same is already analyzing what will be your request, thus facilitating the time to make the purchase and entertain during waiting in line.

In order to develop the process more efficiently, unnecessary activities were eliminated, with the introduction of the box next to the service desk, with a specific employee to receive and pass the change, thus eliminating an activity that was performed by other employees.

In order to develop the care flow, it was analyzed and found that the use of a single queue with 2 channels of care was feasible to supply the demand, thus making the service quick and practical, since the related activities were lean, eliminating unnecessary ones, and redirecting the important activities in the correct order to be applied.

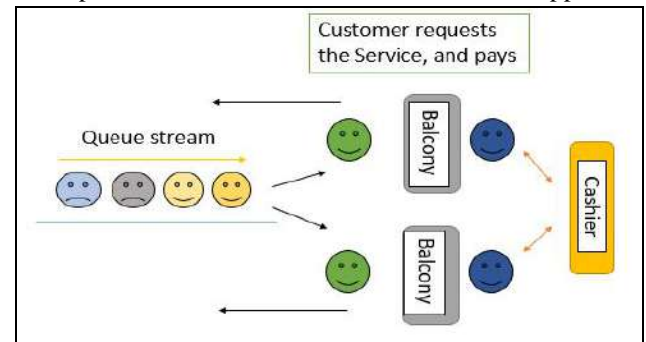


Fig.4: layout proposed

Source: author

The customer upon arrival goes straight to the single queue, while the queue is already analyzing the service you want, and the channels feed and as they are getting free, the time will vary from client to client due to the choice of services that are different and the quantity is also requested, ie a customer choosing a service with greater complexity will take a longer time to be attended, noting that the choice of 1 or more services can occur thus increasing the time in the process, it is worth noting that due to this it is not possible to create a single time parameter for each customer due to these possibility of different quantities and services, the average being used.

V. DATA ANALYSIS

Observing the queue that was formed in the ice cream shop, the data was collected through a digital timer, shown in table 1, the variation of time between arrival, queue and attendance.

Table 1: Data obtained with only 1 channel.

Customers in Queue	Arrival Time (min)	Holding time (min)	Service Time (min)
1	0	3,03	1,93
2	0,38	1,42	0,62
3	0,65	2,35	1,13
4	1,13	4,35	1,91
5	0,53	3,41	2,18
6	1,57	5,25	3,75
7	0,22	2,25	1,37
8	1,28	3,34	2,60
9	1,23	3,67	1,94
10	2,31	2	0,97

With the data collected it is possible to consolidate some information through calculations, using applicable formulas to accurately demonstrate the real situation, thus facilitating the analysis of the facts.

$$P_0 = \text{Prob} \left[\begin{array}{l} \text{system is} \\ \text{empty (idle)} \end{array} \right] = 1 - \frac{\lambda}{\mu}$$

$$L_q = \frac{\text{average number in the queue}}{\text{in the queue}} = \frac{\lambda^2}{\mu(\mu - \lambda)}$$

$$L = \frac{\text{average number in the system}}{\text{in the system}} = \frac{\lambda}{\mu - \lambda}$$

$$W_q = \frac{\text{average time in the queue}}{\text{in the queue}} = \frac{\lambda}{\mu(\mu - \lambda)}$$

$$W = \frac{\text{average time in the system}}{\text{in the system}} = \frac{1}{\mu - \lambda}$$

Note:

λ is the arrival rate.
 μ is the service rate.

Using the data shown in table 1, it was possible to verify the following results:

In the sample of n = 10 clients, it was identified that arrival rate (λ) = 1.07, Service time (TA) = (total service time divided by number of clients) = 1.84 clients / minutes, rate (ρ) = 2.14 clients / minute, average number of clients in the queue (Lf) = 4,03 \cong 4 clients, average number of clients in the system (W) = 3.7 minutes, Average time the customer waits on the system (W) = 5.74 minutes.

Observing the data found in the system with only 1 channel presents an overload due to the arrival rate being higher than the attendance rate with the queue is always

with 4 clients on average, and presents an overload in the client system, thus generating the dissatisfaction of the clients. customers that are waiting in line.

After the new layout was implemented with 2 channels, another data collection was made through digital timer, table 2, following the same parameters of the same data collection, considering the peak time and the same amount of sampling (n) = 10 clients , to be able to compare the two models, the old and the new.

Table 2: Data obtained with 2 channels.

Customers in Queue	Arrival Time (min)	Holding time (min)	Service Time (min)
1	0	0	2,93
2	0	0	0,62
3	1,65	1,2	1,25
4	1,60	2,23	1,41
5	0,50	1,73	1,18
6	1,11	2,65	1,75
7	1,22	1,23	1,85
8	1,08	1,72	1,68
9	0,23	1,85	2,01
10	1,31	1,05	0,79

Using the data shown in Table 2, it was possible to verify the following results:

In the sample of n = 10 clients, it was identified that arrival rate (λ) = 1.15, Service time (TA) = (total service time divided by number of clients) = 1.55 clients / minutes, rate (ρ) = 1.79 clients / minute, average number of customers in the queue (Lf) = 4 clients, average number of clients in the system (L) = 0,64 clients / 5.79 \cong 6 clients, Average time the customer waits in queue (Wf) = 3.5 minutes, Average time the client waits on the system (W) = 5.03 minutes.

It is possible to observe that there was a reduction of the overall time in the system, queuing time was reduced, with the same queue flow and system queues, the queue time was greatly reduced, comparing table 1 with table 2, about 51.28% of the time was reduced by adding a second service channel, leaving the system in equilibrium, the system power is higher and consequently the queue reduces faster, proved by the reduction of 51.28% of the same as previously reported, it is observed that service time was also reduced by around 15.92%, showing that clients are less undecided due to the placement of identification plates, and the service was faster, thus generating a gain end of favorable time, generating a quick and lean flow of time, thus generating customer satisfaction, which is the main goal achieved.

VI CONCLUSION

The application of the queuing theory study in a queue of ice cream shows that the use of Operational Research tools is feasible in small processes and also in simple day to day tasks, demonstrating that it is possible to optimize the performance of real processes, through layout organization.

The system studied had only a single queue to serve a channel, serving 1 client at a time, and it was found that it was overloaded, spent an average of 2.8 minutes in the queue and about 1.8 minutes to be served, showing clearly the delay that the old service system suffered. After applying the new layout that started to be a single queue served by 2 channels, it showed a significant improvement, the average queue time was reduced to 1.3 minutes, and the attendance to 1.5 minutes, the customer service has improved, due to the fact that the service involves several factors, customers take some time to decide the purchase, however it is noticeable that the use of signs and the leaner process influenced the reduction of service time.

Due to the availability of space being reduced, there was an initial difficulty in deciding how to modify the layout, so as not to generate unnecessary costs, because the analyzes are at peak times and at normal times the queue flow is less overloaded.

In order to consolidate the information on customer satisfaction, it is suggested to perform a satisfaction survey to determine if the waiting time is satisfactory, for future studies it is proposed to collect new data at different times and different routine days, such as holidays, weekends, beginning of the month, to see if there is a need to deploy a new service channel in the layout.

REFERENCES

- [1] RINALDI, José Gilberto Spasiani; MORABITO, Reinaldo; TACHIBANA, Vilma Mayumi. A importância da rapidez de atendimento em supermercados: um estudo de caso. *Gestão & Produção*, p. 1-14, 2009.
- [2] MOREIRA, Daniel Augusto. PESQUISA OPERACIONAL-CURSO INTRODUTÓRIO. Cengage Learning Edições Ltda., 2010.
- [3] DE ANDRADE, Eduardo Leopoldino. Introdução à pesquisa operacional: métodos e modelos para a análise de decisão. Livros Técnicos e Científicos, 1998.
- [4] FIGUEIREDO, Danielle Durski; ROCHA, Silvana Heidemann. Aplicação da teoria das filas na otimização do número de caixas: um estudo de caso. *Revista Iniciação Científica*, 2010.
- [5] DE FREITAS FILHO, Paulo José. Introdução à modelagem e simulação de sistemas: com aplicações em Arena. Visual Books, 2001.
- [6] PRADO, Darci Santos do. Teoria das Filas e da Simulação. Belo Horizonte, MG: Editora de Desenvolvimento Gerencial, v. 2, 1999.
- [7] SOUZA, Ana Cláudia et al. Estudo de filas em caixas rápidos de um supermercado utilizando simulação computacional. *Revista Latino-Americana de Inovação e Engenharia de Produção*, v. 3, n. 4, p. 203-222, 2015.
- [8] NEUMANN, Clóvis; SCALICE, Régis Kovacs. Projeto de fábrica e layout. Edição., 2015.
- [9] ROCHA, Henrique Martins. Arranjo físico industrial. 2011.
- [10] SILVA, Alessandro Lucas da. Desenvolvimento de um modelo de análise e projeto de layout industrial, em ambientes de alta variedade de peças, orientado para a produção enxuta. 2009. Tese de Doutorado. Universidade de São Paulo.

The effectiveness and legitimacy of the institute Special Testimony in Brazil and memory

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Abstract— *In this work, we analyze provisions of Law 13,431, from April 4, 2017, which instituted the so-called Special Testimony for the judicial hearing of children and adolescents victims or witnesses of violence, aimed at minimizing the psychological consequences of their participation in the production of oral evidences, as advised by the Federal Council of Psychology, through a technical note, in which it opposes to such procedure, considering that it contributes to the "revictimization" of children who are victims of violence. The main objective was to analyze the effectiveness and legitimacy of the institute, as a guarantor of the rights of these children and adolescents. The approach was interdisciplinary, oriented mainly by theoretical postulates of the fields of memory, psychoanalysis and discourse studies, from which we mobilized some operational concepts*

Keywords— *Criminal Procedure, Memory, Testimony, Violence.*

I. INTRODUCTION

In this work, we discuss the institute of the "special testimony", formerly named "testimony without harm", instituted by Law 13,431 of April 4, 2017, seeking to verify the effectiveness and legitimacy of this procedure as mean of production of legal truth, from the analysis of its compatibility with the principles that guide the practice of psychology as a profession and with the nature of truth objectified by this practice / science and with the nature of the truth proper to the legal field.

The "special testimony" aims to minimize the psychological impacts resulting from the hearing of children and adolescents, victims or witnesses of violence, for purposes of criminal procedural instruction. However, among other allegations, the Federal Council of Psychology (CFP) maintains in the Technical Note 1/2018 / GTEC / CG that the consequences of implementing this procedure would be opposite to those sought by the ordinary legislator, since, instead of guaranteeing protection to the psychological integrity of the minor, it would end up exposing him to a situation of stress and suffering, making him relive the situation of violence suffered or witnessed

We have, therefore, two sciences or practical arts, directly involved in the accomplishment of the special process of hearing of children and adolescents, instituted by Law 13.431 / 2017, psychology and law, which have

different views about the legal discipline conferred to this modality of production of oral evidence, stating formulations on the subject that sometimes contradict each other in relation to the legitimacy of the institute.

II. MATERIAL AND METHODS

The *corpus* of the present analysis is basically composed of two documents: i) the text of the Law 13,431 / 2017, which disciplined the institute of Special Testimony; and ii) The Technical Note n° 1/2018 / GTEC / CG, of the Federal Council of Psychology, which stated a contrary position to the provisions of the above mentioned legal statute, which regulates the Special Testimony.

Because it is a question situated at a point of interaction between the science of Law, more precisely the Criminal Procedural Law, and the Psychology, which despite having points of convergence, present different opinions regarding the hearing of children and adolescents victim or a witness to violence, we opted for an interdisciplinary, as well as a dogmatic and qualitative approach of the *corpus*, from a perspective of analysis of the means of production of truth in the juridical sphere, to which we use, besides works from the field of law, postulates of Foucault ([1974] 2002), and from the prism of memory, when we mobilized the theories of Bergson ([1896] 1999) and Freud ([1896] 1977).

Foucault (1974) states that there are two forms of truth: the "scientific" truth, internal or intrinsic, which is corrected by its own principles of regulation, as in science, and external truth or extrinsic, which is formed in societies in various positions, according to determined "rules of the game", which give birth to certain forms of subjectivity, certain domains of object and types of knowledge.

The legal system of production of truth that prevails today and in which the Brazilian Code of Criminal Procedure is based is derived from what Foucault (1974) calls *examen*, which strongly influenced another system that he identified as "inquiry" and which contrasts with the so-called regime or game of evidence (*épreuve*), in which the criminal procedure was a kind of combat between families, characterized by the absence of a representative of society and the lack of hearing of those who witnessed and / or experienced the events, or by the non-attribution of value of evidence to their testimony

The juridical form of production of the truth that Foucault ([1974] 2002) calls inquiry was based, as well as the examination, by a rational search of the real dynamics of the facts, and was described by the author, from the analysis of the tragedy Oedipus- King, of the Greek playwright Sophocles, as a process of appropriation of the gauging of truth, which was previously on the divine level by the people, through the juxtaposition of scattered fragments, among which the testimony stands out, which assumes, in the tragedy Sophocles, the role of central proof, being that it is through the witness, as was through the testimony that the truth about the life of Oedipus was established.

In the Brazilian criminal procedure system (CPP, art. 155), the evaluation of the evidence is guided by rational persuasion or by the free justified conviction of the judge, a system in which the magistrate has ample freedom in the appreciation of the collection of evidence, being able, in his judgment, to attribute to each evidence produced in the process the value that he deems most appropriate. He must, however, state in the judgment the reasons for his conviction, justifying the burden of proof attributed to each element of conviction relied on in the decision.

The Code of Criminal Procedure in force contemplates several means of collecting of evidences, listed, not exhaustively, in its Title VII, art. 159 to 250. Among those, two are relevant to our work; the testimonial evidence and the offended statements, which may be the object of the so-called Special Testimony. Those means of evidence, in addition to being taken orally, have several common characteristics, more extensively disciplined in the articles that govern the

production of testimonial evidence, among which two are of greater importance for this study: objectivity and retrospectivity.

Objectivity implies the absence of considerations of subjective, evaluative nature on the part of the subject of evidence. This characteristic is expressly disciplined in art. 213, of the Code of Criminal Procedure, *in verbis*: "the judge will not allow the witness to express his personal appreciation, except when inseparable from the narrative of fact."

Retrospectivity, however, implies that the oral evidence will be about facts that are necessarily past; therefore, that can be stored in the memory of the subject of evidence (witness, offended or accused). Addressing the word "memory" as a polysemic term, endowed with different meanings, it is necessary that we discuss some questions related to the mnemonic phenomenon to which the characteristic of retrospectivity of the oral evidence is linked.

The core of Bergson's conception of memory ([1896] 1999) rests on the concept of duration. For this author, it is impossible to conceive time as an orderly succession of facts, with well-defined intervals. In his words: "The division [of temporal flow] is a work of the imagination, which has the function of fixing the moving images of our ordinary experience, like the instantaneous lightning that illuminates during the night a scene of storm" (BERGSON, [1896] 1999, 221).

In his studies, Bergson ([1896] 1999) further differentiates "perception", derived from the senses, from "remembering", anchored in the memory constituted of facts and experiences lived previously. He asserts, however, that such concepts are merely ideal, since the perception, arising from matter (image), is always permeated by memories, in a kind of active present, in which a series of consciences are evoked to help the present moment, whereas, likewise, there is no pure remembrance, since memories are always brought to the surface, bent over a materiality and, therefore, crossed by a perception. Fonseca-Silva (2007) states, referring to Bergson ([1896] 1999), that "the author argues that all perception occurs in a certain duration (name given by the author to time) and implies the intersection with memory, which, linked to a conception of non-spatialized time, accompanies us throughout our lives, maintaining kept in a complete state of virtuality, since it is updated according to present situations and interests (Fonseca-Silva, 2007, p. 15). There is, therefore, in the memory theory developed by Bergson ([1896] 1999), the recognition of the existence of a process of re-signification of the past facts, when evoked in the present, because of the nuances of the

current perception, which is always aided by the by the affectivity and the conjectures of the present events.

Freud ([1896] 1977), in Letter 52, while also addressing the question of memory, states: “our psychic mechanism has been formed by a process of stratification: the material present in the form of traces of memory would being subjected, from time to time, to a rearrangement according to new circumstances - to a retranscription” (Freud [1896] 1977, *apud* Fonseca-Silva (2007, p. 15).

We see, then, that, like Bergson ([1896] 1999), also Freud ([1896] 1977) shares the understanding that there is an actualization, a reframing, a rearrangement of memory in the present moment, so that memory cannot be taken as an indefectible picture of past events. This issue becomes more relevant when such rearrangements of memory occur in relation to legally relevant facts, such as those sought to have access through the collection of statements from witnesses or the offended.

III. RESULTS AND DISCUSSION

The testimonial evidence, as we have seen, assumes decisive role with the emergence of the "inquiry": according to Foucault ([1974] 2002), the Oedipus Tyrannus tragedy marks a transition movement of the verification of the truth that was previously on the divine level, passed to the ruling class and then to the lower classes, thus settling the way in which people obtained the power to judge their own monarchs, through the testimony.

Attributable even to the occupant of the lowest rank in the social hierarchy, the testimony becomes a sound medium for demonstration of truth, in a retrospective condition, turned to the past events, allowing its verification through the intellectual activity, in the sense of linking the statements.

However, the possibility that the testimony contained distortions and / or inaccuracies did not go unnoticed by the Law. In the old Roman provisions on the judicial evidence collection, was established the axiom *testis unus testis nullus*, according to which the evidentiary validity of a single testimony is null and void. This aphorism was not, however, supported by Brazilian law, since, in our system, the validity of the single testimony is admitted.

Malatesta (1996, p. 319), discussing the testimony, states that: “the foundation of the affirmation of the person in general, and of the testimony in particular, is the presumption that men perceive and narrate the truth, a presumption based, in turn, on the general experience of humanity, which shows how in reality and in the greatest number of cases, man is truthful; truthful by the natural

tendency of intelligence, which finds, in fact, more easily than in lies, the satisfaction of a good which is innate.

Still according to the author, this belief in human trustworthiness rules all social relations and without it there would be no possible intellectual progress, since the acquisition of knowledge presupposes faith in the observations and experiences of others. It points, however, to two conditions of credibility, in regard to the person of the witness: first, that he is not mistaken; second, that she does not intent to deceive the judge.

The first of these conditions presupposes the concrete possibility that the witness is mistaken because of distortions in relation to the perception of the witnessed event, as well as because of the (non) preservation of the remembrance.

In regard to this last aspect, according to Giacomolli and Gesu (2008), from an interview granted by Izquierdo, researcher in the area of memory physiology, to the Argentine Journal of Neuroscience (RAN), entitled *The Memory*, which, according to Izquierdo: “in the early hours of its acquisition, declarative memories of long duration are susceptible to interference by numerous factors, from cranial trauma or convulsive electroshocks, to an enormous variety of drugs, and even to the occurrence of other memories. Furthermore, exposure to a new environment within the first hour after acquisition may seriously disrupt or even cancel the definitive formation of a long-lasting memory (Giacomolli and Gesu, 2008, p. 443).

Therefore, even if the witness really believes that he is declaring the truth in his testimony, there is a concrete possibility that the narrated events include divergences from what has actually happened, or even that they do not keep any similarity with the facts occurred, which may result from the phenomenon of perception, which, as we have seen with Bergson ([1896] 1999), is permeated by remembrance.

It is not undisputed, in the jurisprudence of our courts or in the specialized legal literature, that an evidence from an eventual witness or offender shall be attributed the value of an absolute proof, to the detriment of other equally acceptable evidences, taking away from the accused his constitutionally guaranteed presumption of innocence and imposing on him the consequent criminal penalty, notwithstanding jurisprudential precedents that restrain the validity of an evidence to its consistency with other evidentiary elements.

However, there is no denying that such reports are, in many cases, a large part of the body of evidence, with a strong influence on the conviction of the judge, which is why a closer analysis of the so-called Special Testimony

becomes imperative, which is done in the next topic, in which we discuss the legitimacy of this institute as a protective measure of children and adolescent victims of violence.

According to its preamble, the Law No. 13.431 / 2017 "establishes the system of guaranteeing the rights of children and adolescents who are victims or witnesses of violence and amends Law No. 8,069, of July 13, 1990 (Statute for Children and Adolescents)".

With the adoption of this system, a Special Testimony was instituted, which implied altering the procedure for collecting testimony of children and adolescents for purposes of criminal investigation and criminal procedural instruction, seeking to minimize the harmful consequences of their re-exposure to the criminal facts from which they were victims or witnesses. Therefore, the Law 13,431 / 2017 changes the dynamics of the collection of statements, which began to be performed by professionals qualified for this purpose, replacing the usual procedure, which used to be presided over by the magistrate, and necessarily in his presence and the parties acting in the process. The art. 12, caput, of the Law 13,431/2017, establishes that the special testimony will be collected according to the following procedure:

I - Specialized professionals will inform the child or adolescent about the taking of the special testimony, informing them of their rights and the procedures to be adopted and planning their participation, being forbidden to them read the complaint or other procedural documents;

II - The child or adolescent is assured the free narrative about the situation of violence, and the specialized professional can intervene when necessary, using techniques that allow the elucidation of the facts;

III - In the course of the judicial process, the special testimony will be transmitted in real time to the courtroom, preserving secrecy;

IV - upon completion of the procedure provided for in item II of this article, the judge, after consulting the Public Prosecutor's Office, the counselor and the technical assistants, shall evaluate the pertinence of supplementary questions, organized collectively;

V - The professional can adapt the questions to the language of better understanding for the child or adolescent;

VI - The special testimony will be recorded in audio and video.

Although the law does not indicate the technical qualification required by the professional who will conduct the Special Testimony, referring to him just as "specialized professional", it is understood that, given the

nature of the intervention and the legal purpose of protecting the any damage resulting from the conduct of his or her hearing and the remembrance of the criminal acts of which he or she was a victim or witness, such *munus* shall fall on a professional qualified to evaluate the psychic consequences of the collection of the testimony, which requires knowledge and skills pertaining to the area of Psychology.

Notwithstanding that the purpose of the law is to protect the declarant from possible harmful consequences of his / her re-exposure to the criminal acts suffered or witnessed, through the performance of a professional that leads the hearing in the least harmful way possible, the Federal Counsel of Psychology (CFP) has manifested itself, as already seen, contrary to the adoption of the procedure, by means of Technical Note No. 1/2018 / GTEC / CG, expressly recommending that psychologists and psychologists "do not participate in the inquiry of children through special testimony", with the argument that "in the name of protection, the special testimony violates the right of children and adolescents who are the object of preponderant evidence in criminal proceedings, disregarding their peculiar situation as a developing person and their dignity and "that is not the attribution of the psychologist to perform special testimony for it harms confidentiality and professional autonomy."

Discussing on the "testimony without harm", a proposal that served as an inspiration for the current Special Testimony, Conte (2009, p. 74) establishes a series of questions:

When a child is asked to tell about an experience that is of the traumatic order for it, can we use a criterion of truth (objective), leaving aside the enigma of the subjective event that has not yet been dealt with psychically? Is truth a possible category to be thought of, when the event was not translated, repressed, and forgotten? When the event is still an enigma in search of a meaning, doesn't it opens up the possibility of the symbolic?

In the proposal of the testimony without damage two questions are at stake, the search for truth, when the implication of this talk is the arrest of the abuser, usually a relative; the second question is that in view of the non-forgetfulness of the traumatic situation, speaking assumes the dimension of act, putting the event back on the scene.

Thus, the demand for validity in the child's report, when it is exposed to a testimony, evidences a paradox, since it must reveal and hide. Reveal what was asked for the investigation (the objective truth) and hide what happened (the subjective experience of pain, shame and passivity). Speaking appears as a symptom, because it

seeks to reveal the truth (the said) when the psychic (the unsaid) suffering is what overflows. The necessary gap between the spoken and the unspoken can occur in a context of listening to the child, otherwise we can speak of re-victimization.

In other words, what the author argues is that, given the peculiarity of the fact experienced by the child or adolescent, which would still lack processing by its psychic apparatus, enabling repression (confinement of what happened at the level of the unconscious) or elaboration / signification of the event, the submission of the victim to the act of the testimony would imply in a situation of not forgetting the traumatic experience, which, consequently, would lead to a situation of re-victimization of the child or adolescent.

It is also necessary to observe, with Freud (*apud* CONTE, 2009, 73), that "psychic reality is a particular form of existence that must not be confused with material reality", that is, what has been recorded in the psyche of the victim, so as to be capable of remembrance (evocation), does not necessarily keep perfect symmetry with what actually occurred (material reality), thus being the Special Testimony consisting of misleading accounts, not because of the will of the victim to misrepresent the facts, but because of the memory failures to which it is subject and which we discussed above.

Thus, the question of the legitimacy of the institute of Special Testimony finds its focal point in the necessary balance between values equally protected in the Federal Constitution: on the one hand, the dignity of the developing human person (in this case, child or adolescent victim or witness to violence) and, on the other hand, the guarantee of effective criminal protection, which obliges the State to repress the crimes that are subject to its jurisdiction, since it has a monopoly of the power to punish, being disallowed to individuals, except in situations provided by law (legitimate defense, state of necessity, etc) to promote "justice with one's own hands".

IV. CONCLUSION

The views expressed in texts concerning juridical science as well in the texts on psychology show that, although both sciences seek the truth, the material content of the terminology is distinct in each of these areas of knowledge. In the field of law, it is characterized as external truth, linked to the real dynamics of facts that have some relevance to the application of laws, whereas Psychology deals with the "psychic truth", internal to the individual, which does not necessarily manifest strict coincidence with the real dynamics of the facts, being

more related to the perceptions and representations made by the individual concerning the facts he experiences.

The practice of violence against children and adolescents is a real fact that inspires the need for effective action by the State, in guaranteeing the effective protection of these human beings in particular condition of development. However, regarding the subject of the present study, the purpose of protection is found in both poles of the discussion presented above, which is related to the legitimacy of the Special Testimony. The authors of Law 13.431 / 2017 defend that the institute integrates a system that guarantees the rights of the child and adolescent victim or witness of violence, while the Federal Council of Psychology argues that the defense of these rights is given by not adopting the institute, since it violates the special situation of these "people in development."

That being so, and considering that, for the necessary imposition of a criminal sanction on the perpetrators, there is a legal requirement to produce adequate and sufficient evidence to establish the judge's conviction for the culpability of the accused, it is reckless to legality prevent the victims to provide testimony in the judicial context. It is imperative that an attempt is made to harmonize between the defense of the psychic integrity of these subjects and the possibility of producing oral evidence with their participation, so as not to allow its perpetrators go unpunished.

REFERENCES

- [1] Bergson, H. ([1896] 1999). *Matéria e memória: ensaio sobre a relação do corpo com o espírito*. [Matière et mémoire: Essai sur la relation du corps à l'esprit] Trad. Paulo Neves. 2ª ed. São Paulo: Martins Fontes.
- [2] Conte, B. de S. A escuta psicanalítica e o inquirido no depoimento sem dano. In: CONSELHO FEDERAL DE PSICOLOGIA; COMISSÃO NACIONAL DE DIREITOS HUMANOS DO CFP (Org.). *Falando sério sobre a escuta de crianças e adolescentes envolvidos em situação de violência e a rede de proteção: propostas do Conselho Federal de Psicologia*. 1ª ed. Brasília: Conselho Federal de Psicologia, 2009. pp. 71-78. Available: <http://www.crp.org.br/portal/comunicacao/diversos/mini_cd/pdfs/cfp_falando_serio.pdf>. Last accessed on: 05 abr. 2019, at 14h49min.
- [3] Fonseca-Silva, M. da C. (2007). *Mídia e Lugares de memória discursiva*. In: FONSECA-SILVA, M. da C.; POSSENTI, S (Org.). *Mídia e Rede de Memória*. Vitória da Conquista: Edições Uesb. pp. 11-37
- [4] Foucault, M. ([1974] 2002). *A verdade e as formas jurídicas*. Rio de Janeiro: NAU Editora.
- [5] FREUD, S. Carta 52. ([1896] 1977). In: *Edição standard brasileira das obras psicológicas completas de Sigmund*

Freud. v. 01. Trad. Jayme Salomão. Rio de Janeiro: Imago Editora Ltda, 1977.

- [6] Giacomolli, N. J.; Gesu, C. C. di. As falsas memórias na reconstrução dos fatos pelas testemunhas no processo penal. In: Congresso Nacional do CONPEDI, 17., 2008. Brasília, DF. Anais do XVII Congresso Nacional do CONPEDI. Florianópolis: Fundação Boiteux, 2008. p. 4334-4356. Available in: <
[http://s3.amazonaws.com/conpedi2/antiores/XVII+Congresso+Nacional+-+Bras%C3%ADlia+\(20%2C+21+e+22+de+novembro+de+2008\).pdf](http://s3.amazonaws.com/conpedi2/antiores/XVII+Congresso+Nacional+-+Bras%C3%ADlia+(20%2C+21+e+22+de+novembro+de+2008).pdf)>. Last accessed on: 05 abr. 2019, às 11h36min
- [7] Malatesta, N. F. D. A (1996). Lógica das Provas em Matéria Criminal. [La logica delle prove in criminale] Trad. Paolo Capitanio, Campinas: Bookseller.

Electricity Generation from Biogas of Cassava using Cattle Manure as inoculum: An Assessment of Potential in the Quilombola Community (Brazil)

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Abstract— The bioenergy has turned into a good alternative for reducing the emission of pollutant gases. In Brazil, the use of this type of energy has increased in the last decades. Biogas, produced from cassava, appears as an alternative fuel to fossil fuels and, also, becomes economically competitive, since this is a low cost carbon source. Anaerobic biodigesters that use renewable raw materials are known as a technology with great potential for biogas production which is considered a source of clean energy. Biogas produces sustainable energy and consists mainly of methane (60%) and carbon dioxide (35% to 40%). This study presents the biogas potential from the cassava processing residual water for the production of dry flour (manipueira). The results of this study indicated that the biogas potential is 1.389.312 cm³ per year from a single-stage reactor with a capacity of 60 liters using manipueira as substrate and inoculated with cattle manure, which could provide a generation of electricity of 214 kwh/year.

Keywords— *Biogas, Cattle Manure, Quilombola Community.*

I. INTRODUCTION

Several quilombola communities do not have access to electricity due to the cost of distribution and territorial difficulties. Alternatively, many of these communities adopt isolated power generation systems that typically adopt renewable sources such as solar, biogas, wind or internal combustion. Although these communities have access to electricity, much of the community, in general, has no purchasing power to use this type of energy freely.

On the other hand a strong characteristic of these quilombola communities and the production of different types of biomass. Considering that biomass is the raw material for the production of biogas, the use of biodigester for the production of electric energy is a good alternative for the production of electric energy, considering that small generators are able to convert biogas into electric energy.

The intensive depletion of fossil fuel resources due to their huge utilization with the abrupt fluctuation in oil and fossil fuel energy source prices has led to increasing trends towards finding renewable and cost-wise green energy alternatives (Abdeshahian *et al.*, 2014). On the other hand, the greenhouse gases (GHG) act as a determinant factor in global warming by surrounding the heat reflected from the earth surface with the highest contribution of CO₂(60%) and less effect of CH₄ (15%) (RAHIMNEJAD *et al.*, 2015).

In this way, the development of sustainable technologies for the production of bioenergy has become an attractive alternative for the energy sector regarding reduction of pollutant emissions. The need to change the energy matrix, due to several factors, has provided great incentive for the insertion of this form of energy generation in Brazil and many countries around the world (MADEIRA *et al.*, 2017a).

The production of biogas through Anaerobic Digestion (AD) offers significant advantages over other forms of bioenergy production. It has been evaluated as one of the most energy-efficient and environmentally beneficial technology for bioenergy production (FEHRENBACH *et al.*, 2008). Biogas generation can drastically reduce greenhouse gases compared to fossil fuels by utilization of locally available resources. The digestate represents an improved soil conditioner which can substitute mineral fertilizer (WEILAND, 2010).

Many studies have been made on the AD process of biogas production using different biomass as mono-substrates (KHALID *et al.*, 2011 BABAEE *et al.*, 2013; SALMINEN and RINTALA., 2002). The major problem of the direct use of substrates is the fate of certain anaerobic bacteria and the low diversity of nutrients. The co-digestion process was recommended to overcome the difficulty, like mixing agricultural byproduct with cattle manure (MATA-ALVAREZ *et al.*, 2000).

Cassava wastewater is a byproduct of the cassava processing plant, an effluent with high potential for biohydrogen production. Its potential for energy production has gained strength in the last years (ANYANWU *et al.*, 2015; CHALEOMRUM *et al.*, 2014; MADEIRA *et al.*, 2017b). Cassava wastewater exhibits high polluting effects due to the increased BOD level and for containing hydrocyanic acid, which makes this residue different from others of the agroindustry (FIORETTO, 1994). According to LACERDA (1991), this toxicity from cyanidric acid is attenuated, because in his studies on the kinetics of the methanogenic phase, using cassava

wastewater as the substrate, concluded that the removal of cyanide obtained 37.5% of efficiency.

The AD of manipueira due to high starch concentration is impaired by a slow rate of methanogenesis which generally acidifies the substrate. An alternative to avoid acidification of the process is the use of inoculum, because at the beginning of the AD process the amount of acids and hydrogen is higher as a function of the rate of generation of the acid forming bacteria, the addition of a sufficient amount of methanogenic organisms, through the use of the inoculum, can prevent imbalance.

II. MATERIALS AND METHODS

2.1. Study site

The municipality of Angra dos Reis is located in the state of Rio de Janeiro, located over the Southeastern part of Brazil as shown in Figure 1. The municipality has a territorial area of 825,082 km² and a population of approximately 184,940 inhabitants (IBGE, 2014).

The project was created and implemented in the Quilombo de Santa Rita, located in the municipality of Angra dos Reis, located at latitude 22°54'2.322 "S and longitude 44°24'48.895" W, as shown in Figure 1. This village is made up of approximately 110 families of which, a significant part, exclusively develops rural activity for their subsistence. It is a village with characteristics determined by the historical formation of the municipality, where the quilombos express the memory of Afrodescendant culture, maintaining cultural traditions of religion, dance, subsistence, and other manifestations (REIS 2013).

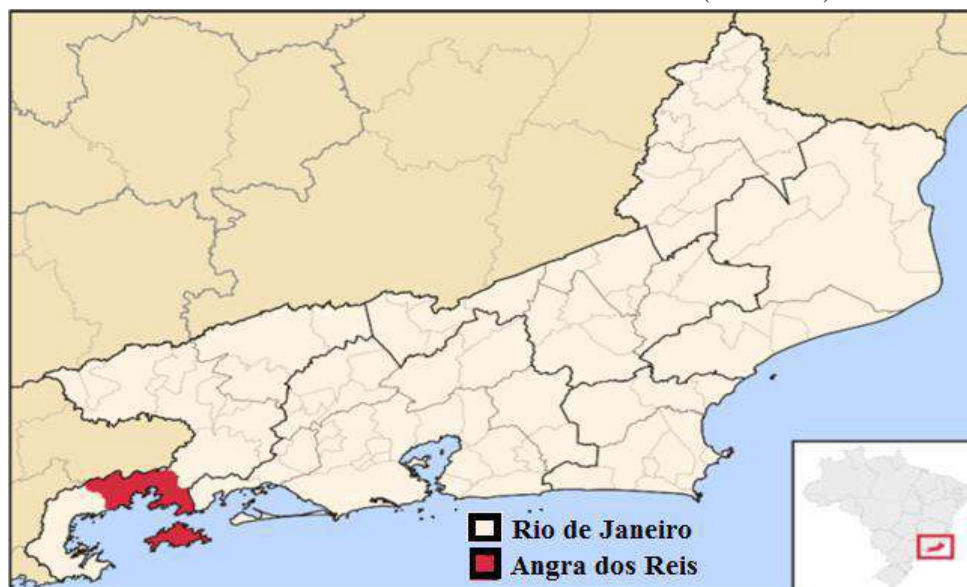


Fig.1: Location map for Angra dos Reis

In his will, opened in 1879 nine years before the abolition of slavery, the Commander Breves freed all his slaves and made a formal donation of the property for those who were living in Bracuí, that is, ancestors of current residents of the community. Despite the donation, since the 1960s the "quilombolas" struggle against land grabbers and try to avoid the construction of luxury condominiums so they can stay on the land inherited by law (PMAR, 2018).

The raw materials that constituted the present study were: manipueira (substrate); cattle manure (inoculum). The cattle manure and the residue of the production process of cassava flour (manipueira) used in the present study was obtained in the Quilombola

community, due to the high production of manipueira for subsistence and the creation of horses throughout the whole Quilombo.

2.2. Biodigester construction

The manipueira, used as substrate, was mixed with cattle manure, used as inoculum and the ratio used, respectively, was 75% and 25%. The biodigester constructed was a discontinuous flow digester (single-stage reactor). Each batch biodigester was composed for just one container: digestion chamber (70 liters), net digester volume (60 liters), the remaining 10 liters accumulate the gas, functioning as a gasometer, as described in Figure 2.



Fig.2: Single-stage reactor with a capacity of 70 liters

In the lid of the digestion chamber was installed a copper pipe to rubber tube gas valve (biogas outlet), this pipe connect the digestion chamber to a stove burner gas mouth. This camping stove has been adapted because the gas outlet hole has less than 1mm of diameter, which does not allow the flow of the biogas, since it is under low pressure. In this way the hole diameter was enlarged to 5mm, allowing the gas flow efficiently.

The average temperature of the biodigesters along the hydraulic retention time (HRT) was 28 ° C and twice a week 30 ml of biogas was collected for characterization. For the storage of the biogas to the laboratory where the characterizations of the biogas were carried out, it was necessary to prepare vials for the storage and transportation of biogas. The Penicillin vials was sealed

and had its internal volume filled with sealing liquid prepared according to DIN 38414-8 (DIN, 1985) (solution consisting of 30 mL of sulfuric acid, 200 g of sodium sulfate decahydrate and some drops of methyl orange gauge). The biogas characterization was performed at the Biomass and Water Management Research Center, Fluminense Federal University, from a gas chromatograph (GC-FID / TCD Agilent, model 7890B).

2.3. Calculation of the potential of electric energy generation from biogas

For the calculation of heating value of the methane generated, it was assumed that 85% (efficiency) of the methane evolved could be converted to heat (ABDESHAHIAN *et al.*, 2016) in the boiler by

considering a calorific value of 36 MJ per cubic meter of methane (36 MJ/m³) (FBHEF, 2018).

The potential of electricity generation from the biogas was calculated according to Equation 1:

$$e_{biogas} = E_{biogas} \cdot \eta \quad (1)$$

Where:

e_{biogas} : quantity of generated electricity (kWh/year);

E_{biogas} : unconverted raw energy in the biogas (kWh/year);

η : denotes the overall efficiency of the conversion of biogas to electricity (%).

The parameter η varies according to the power generation plants. The η value is considered from 35 to 42% and 25% in the power plants with large turbine system and small generators, respectively (BENITO *et al.*, 2015). In this study, the η value was assumed as 25%, because the capacity of the biodigester used is small. The quantity of E_{biogas} : is calculated using Equation 2:

$$E_{biogas} = LHV_{biogas} \cdot \dot{m}_{biogas} \quad (2)$$

Where:

LHV_{biogas} : calorific value of biogas (kWh/m³);

\dot{m}_{biogas} : amount of biogas produced per year (m³/year).

In this equation, the LHV of the biogas is considered as the LHV of the methane multiplied by the percentage of methane contained in each of the biogases, as described by Equation 3:

$$LHV_{biogas} = P_{ch4} \cdot LHV_{ch4} \quad (3)$$

Where:

P_{ch4} : percentage of methane contained in biogas (%);

LHV_{ch4} : calorific value of methane (kWh/m³).

The LHV_{CH4} used was 9,9519 (kWh/m³) (Braga *et al.*, 2013). The biodigester's operating time was approximately one month, which is equivalent to 12 batch per year, so from a production reference of 0.115776 m³/month per month, so it is possible to estimate the production of 1.389312 m³/year.

III. RESULTS AND DISCUSSION

A small fraction of inoculum can generate biogas. This is due to the fact that even though the cattle manure is important due to the large amounts of anaerobic microorganisms in the digestive tract of these animals, but excess of lignin present in ruminant animals manure disrupt methane production and thereby decrease biogas production and consequently produce poor quality biogas (low CH₄ concentration).

Ruminant's manure have significant amount of lignin (Table 3), which is a phenolic compound of difficult degradability and when complexed with cellulose and hemicellulose not allow conversion of these compounds in precursors of biogas [20-23]. In this way, it was predicted that excess cattle manure could disrupt the biodigestion process

Another parameter that also contributes to a low inoculum ratio used is the Carbon/Nitrogen (C/N) ratio, as shown in Table 1. According to literature it is recommended that the C/N ratio in substrate be in the range of 25-30 for the anaerobic digestion process. [17].

Table 1: C/N ratio, lignin, hemicellulose and cellulose concentration.

Inoculum / Substrate	C/N	Cellulose (g/kg)	Hemicellulose (g/kg)	Lignin (g/kg)
Livestock manure	13.9 [16]	110 [18]	80 [18]	140 [18]
Cassava	19 [17]	250 [19]	70 [19]	30 [19]

The biodigester produced gas with an average concentration of 62% and the accumulation of biogas volume was 115,776 cm³. The Figure 3 shows the volume of biogas produced during the HRT.

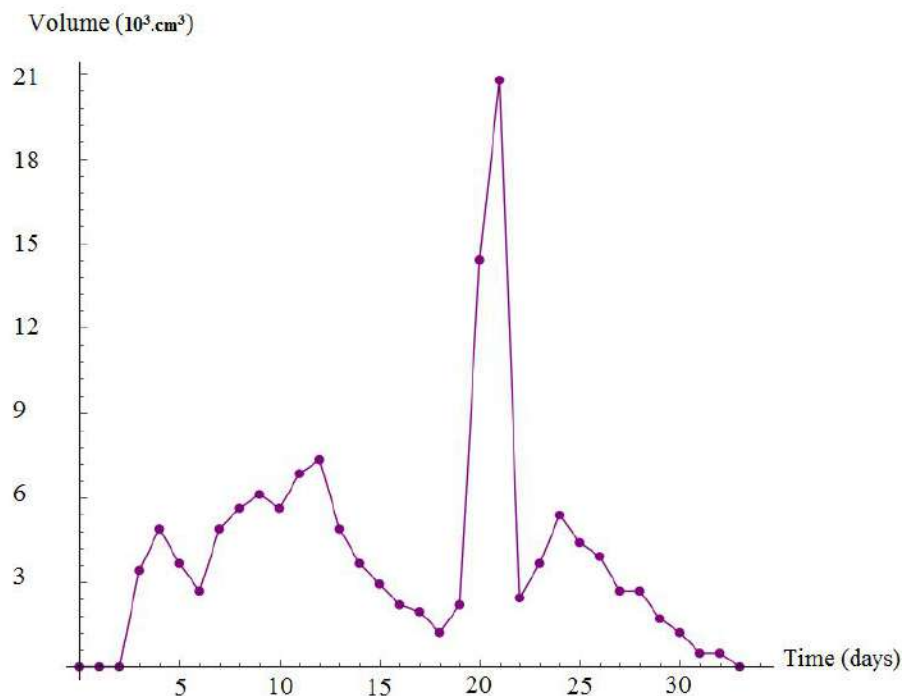


Fig.3: Volume of biogas produced in the biodigester under study along the HRT

The produced biogas can be converted into electrical energy from a small generator. The 60 liter biodigester of net value is capable of generating 2.14 kwh/year. In Table 2 we can see the comparative of the energy produced applied to some electronic devices.

Table 2: Days of operation using the energy provided by a small generator fed by the biogas under study

Description	Assumed daily time (hours)	Operating energy (Wh/dia)	Days of operation using the energy provided by a small generator fed by the biogas under study
Computers (laptop)	3	203.07	10.55
Home audio	3	165.93	12.91
Televisions (CRT)	3	150.78	14.21
Televisions (LCD)	3	490.23	4.37
Microwave ovens	0.34	150.28	14.26
Washing machines	0.5	375	5.71
Electric shower	0.67	1571.15	1.36
Fan	8	6400	0.33
Refrigerator	24	115200	0.02

Table adapted from GUAN et al. 2011.

IV. CONCLUSION

The inoculation of manipueira with cattle manure presented satisfactory results, because with a small amount (close to 25%) of inoculum, it was possible to create a biodigester with a satisfactory biogas recipe and a percentage of methane sufficient to create a flammable biogas. A biodigester with a capacity of 60 liters is able to produce enough biogas, which converted into electricity, is capable of supplying small electrical devices. However for electricity production to become viable, ideally a

larger capacity biodigester or several biodigesters connected in series should be used.

There are several studies related to the production of biogas from the manipueira, however, in general, in these studies, single-stage reactors are used, because the AD of manipueira due to high starch concentration is impaired by a slow rate of methanogenesis which generally acidifies the substrate. A small amount of manure inoculates the substrate with the intestinal

bacteria of the animals and does not present enough lignin to acidify the substrate.

Thus, single-stage reactors can be used to produce biogas and/or electricity using manipueira as substrate, but efficient production of electricity, biodigestors that operate with large volumes of substrate are recommended.

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REFERENCES

- [1] ABDESHAHIAN P, AL-SHORGANI NKN, SALIH NKM, SHUKOR H, KADIER A, HAMID AA, KALIL MS. The production of biohydrogen by a novel strain *Clostridium* sp. YM1 in dark fermentation process. *Int J Hydrogen Energy* 2014;39:12524–31.
- [2] ABDESHAHIAN, P., LIM, J. S., Ho, W. S., HASHIM, H., & Lee, C. T. (2016). Potential of biogas production from farm animal waste in Malaysia. *Renewable and Sustainable Energy Reviews*, 60, 714-723.
- [3] ANYANWU, C.N., IBETO, C.N., EZEHOA, S.L., OGBUAGU, N.J. Sustainability of cassava (*Manihot Esculenta* Crantz) as industrial feedstock, energy and food crop in Nigeria. *Renew. Energy* 81, 745–752. doi:10.1016/j.renene.2015.03.075, 2015.
- [4] BABAEE A, SHAYEGAN J, ROSHANI A. Anaerobic slurry co-digestion of poultry manure and straw: effect of organic loading and temperature. *J Environ Health Sci Eng* 2013;11.
- [5] BENITO, M., ORTIZ, I., RODRÍGUEZ, L., & MUÑOZ, G. (2015). Ni-Co bimetallic catalyst for hydrogen production in sewage treatment plants: biogas reforming and tars removal. *International journal of hydrogen energy*, 40(42), 14456-14468.
- [6] CHALEOMRUM, N., CHOOKIETWATTANA, K., DARARAT, S. Production of PHA from Cassava Starch Wastewater in Sequencing Batch Reactor Treatment System. *APCBEE Procedia* 8, 167–172. doi:10.1016/j.apcbee.2014.03.021. 2014.
- [7] DEUTSCHES INSTITUT FÜR NORMUNG (DIN). DIN 384140-8 German standard method for the examination of water, waste water and sludge. Sludge and sediment (group S). Determination of amenability to anaerobic digestion (S8), 1985.
- [8] DOS SANTOS, W. F., JR, J. C. Z., DA NOBREGA, S. L., & MARÇON, R. O. Análise da viabilidade econômica em um sistema híbrido solar-eólico na geração de energia elétrica para uma comunidade isolada e quilombola do Jalapão-to1.
- [9] FEHRENBACH H, GIEGERICH J, REINHARDT G, SCHMITZ J, SAYER U, GRETZ M. Criteria for a sustainable use of bioenergy on a global scale. Federal Environment Agency Germany, prepared by the Institute for Energy and Environmental Research (IFEU), Heidelberg 2008, 245 p.
- [10] FIORETTO, R. A. Direct use of the cassava wastewater in fertigation. *Série culturas de tuberosas amiláceas Latino Americanas*, v. 4. São Paulo, 1994
- [11] FROM BIOGAS TO HEAT, ELECTRICITY AND FUEL. (http://www.methator.com/en/bio_gas-heat-electricity-fuel)
- [12] GARCIA A.P. Techno-economic feasibility study of a small-scale biogas plant for treating market waste in the city of El Alto. Master of Science Thesis EGI 2014. KTH School of Industrial Engineering and Management, Division of Energy and Climate
- [13] GUAN, L., BERRILL, T., & BROWN, R. J. (2011). Measurement of standby power for selected electrical appliances in Australia. *Energy and Buildings*, 43(2-3), 485-490.
- [14] IBGE. 2014. Pesquisa nacional por amostra de domicílios. Online: <https://sidra.ibge.gov.br/pesquisa/pnad>.
- [15] KHALID A, ARSHAD M, ANJUM M, MAHMOOD T, DAWSON L. The anaerobic digestion of solid organic waste. *Waste Manag* 2011;31:1737–44.
- [16] LACERDA, T. H. M. Kinetic study of the methanogenic phase of cassava wastewater substrate, 114p. Tese (Doutorado em Agronomia /Energia na Agricultura) – Faculdade de Ciências Agrônomicas, Universidade Estadual Paulista. São Paulo, 1991.
- [17] MADEIRA, J. G. F., BOLOY, R. A. M., DELGADO, A. R. S., LIMA, F. R., COUTINHO, E. R., & de CASTRO P. F (2017a). Ecological analysis of hydrogen production via biogas steam reforming from cassava flour processing wastewater. *Journal of cleaner production*, 162, 709-716.
- [18] MADEIRA, J.G.F., DELGADO, A.R.S., BOLOY, R.A.M., COUTINHO, E.R. AND LOURES, C.C.A. (2017b) Exergetic and economic evaluation of incorporation of hydrogen production in a cassava wastewater plant. *Applied Thermal Engineering*.
- [19] MATA-ALVAREZ J, MACE S, LLABRES P. Anaerobic digestion of organic solid wastes. *Overv Res Achiev Perspect Bioresour Technol* 2000;74:3–16.
- [20] PMAR, 2018 <http://mapadecultura.rj.gov.br/headline/quilombo-santa-rita-do-bracui>
- [21] RAHIMNEJAD M, ADHAMI A, DARVARI S, ZIREPOUR A. Oh S-E. Microbial fuel cell as new technology for bioelectricity generation: a review. *Alexandria Eng J* 2015;54:745–56.
- [22] REIS, D. 2013. Modelagem do barro: Muquém, Rio de Janeiro: IPHAN.
- [23] SALMINEN E, RINTALA J. Anaerobic digestion of organic solid poultry slaughterhouse waste - a review. *Bioresour Technol* 2002;83:13–26
- [24] WEILAND P. Biogas production: Current state and perspectives. *Applied Microbiology and Biotechnology* 2010; 85(4): 849-860

High Cost of Organizational Moral Harassment for Companies who Practice It

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Abstract— *The purpose of this article is to identify the most relevant court decisions in the second instance, in order to verify the amount of convictions applied by the Regional Labor Courts to companies that practice organizational or collective moral harassment as a form of management, also called stress management. It also seeks to assess what types of bullying practices and whether there has been a repeat offense. For that, an exploratory research was carried out, with online documentary analysis, quali / quanti, from 2006 to 2016. In order to study the theme, the research was conducted at <http://liber.advisebrasil.com.br/liber>, which stores the publication of the sentences issued in second degree of all courts including the 24 Regional Labor Courts. We used search filters for public civil action, second-degree sentences, type of organizational harassment practices. It was found that the convicted companies were convicted of various harassment practices, such as aggressive management by shouting, swearing, pejorative nicknames, subjecting workers to vexatious situations in public, abuse in the demands of unattainable goals, accomplishment of tasks above or below capacity, retaliate against strikers, prevent workers from striking, racial discrimination, aesthetics, pregnancy and homosexuality, prejudice, employee isolation, threats of dismissal, forcing an employee to resign, using subterfuges to find fault in the work of the employees, persecution of the workers, intimate magazines, to prevent the worker from taking water or use of the bathroom, to maintain work environment in unhealthy conditions and with risks of illnesses and accidents at work. There was a recurrence in the practice of aggressive management, demonstrating that the value of condemnation of pedagogical-punitive character, did not have an effect, in the case of large drink companies and financial institutions.*

Keywords— *Organizational harassment, Directive power, Abuse.*

I. INTRODUCTION

This article deals with private organizations convicted in public civil action, through denunciation by the category union, for the practice of organizational moral harassment. Convictions by the judiciary aim at a pedagogical-punitive character, as a form of combat to this type of aggressive management.

Everyone knows that the employee is the disadvantaged part of the work relationship, and there are employers who opt for a more aggressive management, in addition to various types of abuse such as restraint in the time of use of the bathroom, video cameras installed in bathrooms in department stores, vexatious situations that are submitted to sellers when they do not reach goals often unattainable, gender, color, sex, religion, among others.

Since the enactment of Constitutional Amendment (CA) 45/2004 in its art. 114, which defined that the Labor Court is competent to assess damages for material and moral damages in remedial actions that enter the Labor Judiciary. In cases of proven organizational or collective moral harassment, the convictions are high values, but proportional to the economic and financial conditions of the condemned company, not to bring about the closure of the same, or even the unemployment of many employees. Is the value applied in condemnations of a pedagogical-punitive nature for companies that have management style as organizational moral harassment really having an effect?

Its purpose is to identify the most relevant sentences in the second instance, in order to assess the amount of convictions in the period from 2006 to 2016

and if there was repeated offense, and the types of practices of these convicted organizations. To study the topic, the research was conducted at <http://liber.advisebrasil.com.br/liber>, which publishes the decisions of all courts, including the 24 Regional Labor Courts.

In order to meet the objective, the sentences were analyzed considering the following aspects: public civil action, second degree sentences, type of practices of harassment, organizational or collective harassment.

This article is structured in four sections, including this introduction. Following is the theoretical reference with the contextualization of organizational moral harassment and public civil action, followed by a description of the methodological procedures used, analysis of the results and finally the final considerations.

II. THEORETICAL REFERENCE

CONTEXTUALIZING ORGANIZATIONAL MORAL HARASSMENT

In order to keep up with changes in the economic context, organizations are looking for more flexible hierarchical compositions, organized in networks, with a focus on projects and temporary contracts, to respond quickly to market demands and maintain competitiveness standards (ARENAS, 2013).

According to Eberle; Soboll; Cremasco (2009) we live in a reality of work in which "there is no long term", in which the market is governed by an impatient capital, that demands fast return, it reaches the relations and the social bonds, corroding the trust, the loyalty and mutual commitment.

Barreto (2006) goes on to say that the reflexes of these changes in the ways of producing and organizing work marked the last two decades of the last century, bringing, among other consequences, the breaking of social rights, reforms in the labor contract, outsourcing and quarantine, growth of the informal sector, increase of underemployment, precariousness of labor, massive unemployment and increase of urban misery. The repercussions on workers' lives were immediate, demanding more technical efficiency, competitive and aggressive spirit, flexibility and multi-functionality, restructuring and the consequent downsizing of the business machine began to demand more work with fewer people.

The demands imposed on the workers grow, such as excellence in quality, commitment to achieve it, overtime, production quotas to be achieved, more creativity in solving problems, increasing the pace, more productivity without offering adequate conditions. Soboll (2008)

comments that the sale of products is marked by abusive goals, increasing and unrealistic in relation to the market, determined without the participation of the workers, imposing extreme dedication to reach, at times, at almost unattainable levels.

Even with the technological advance, the new work organization did not bring the announced end of the hard work; on the contrary, inequalities and social injustice, and forms of suffering that are qualitatively more complex and subtle, especially from the psychic point of view, have been accentuated, thus removing from work their ontological character as a promoter of well-being and way of constructing history individual, social identity and, mainly, source of pleasure and personal growth (ARENAS, 2013).

Heloani (2004) argues that when a dose of moral perversion is encouraged by harmful organizational practices it can easily lead to a process of moral harassment. According to Soboll (2008) inhuman and inappropriate strategies are used in group management, with offensive words, shouts, curses, relegations and contePPO. In these cases there is a formal abuse of power, which is often repeated at all hierarchical levels.

The prospect is that individuals will survive in the labor market, surpassing themselves, becoming increasingly competitive and efficient than peers or competitors, pushing for individualism. This competitiveness according to Dejours (2006) instigates the banalization of unfair behavior among co-workers. For Hirigoyen (2005) when they are pressuring us, charging, treading, we forget the other as a person, we no longer have to let ourselves be emotionally involved, there is no space, and rare expressions of companionship, solidarity and appreciation of others .

According to Dejours (2006), the machinery of the "economic war", which does not represent military equipment but competitiveness, is only effective because people who are subjected to it and those who are not able to fight in this "economic war" are dismissed from the companies or pressured to resign. Freitas (2001) explains that some organizations use various tactics or techniques to force people who are considered to be unwanted or have no great contribution to make, in order to overcome them by fatigue and cause them to resign. This is the kind of practice used to cut costs and has occurred quite frequently, especially in cases of mergers and acquisitions, where certain tasks and positions are duplicated. It is also very common to use the quarantine or freezer tactic or symbolic death by means of simple facts to destabilize, taking the person's table or chair to

sit, reinforcing their uselessness (HIRIGOYEN, 2005; GUEDES, 2008).

The manipulation and domination behaviors adopted by some managers, in the form of threats of punishment, damages, exclusion and dismissal, contribute to the emergence or maintenance of fear, and even anguish, in work environments (EBERLE; SOBOLL; CREMASCO, 2009). It has a management strategy effect in formatting the workers' collective, providing submission and adherence to organizational objectives, without questioning (SOBOLL, 2008). This fear is permanent and leads to obedience and submission (DEJOURS, 2006). They are used by organizations and management to achieve their interests, such as control, submission of workers, increase of productivity, acceleration of work, causing workers to submit fearful of not complying with company requirements, being fired, etc., increases the control of the subjectivity and conduct of workers by the company (EBERLE; SOBOLL; CREMASCO, 2009).

Einarsen (2000) describes organizational harassment as situations in which managers, individually or collectively, reinforce perceived organizational structures and procedures as oppressive, degrading, humiliating, and when frequent and persistent, reach many workers simultaneously. Dejourns (1987) states that fear is also an instrument of social control, and is used by management as a real lever to make work work, to achieve productivity goals. Fear serves productivity, for the fear of losing employment makes workers especially sensitive and attentive to any anomaly, any incident in the development of the production process.

Eberle, Soboll and Cremasco (2009) explain that the instrumental use of fear occurs in a context of superficial relations, with a predominance of individualism and lack of solidarity, favoring the occurrence of abuse and disrespect, including practices of interpersonal and / or organizational structure. Hirigoyen (2005) emphasizes the fundamental role of fear in the practices of bullying as an indispensable motor, because it is out of fear that one becomes violent, adopts hostile and even aggressive behaviors in the sense of attack before being attacked. He shows panic at the thought that someone can prove to be better than taking his position or replacing him (Guedes, 2008). The managers' fear is that their own difficulties become apparent, that this is attributed to their incompetence, that their colleagues use this information against them, that it will serve as an argument to include them in the next list of layoffs (DEJOURS, 2006).

Dejourns (2006) argues that managers, through their own experience of fear, know that, with the threat of dismissal, they can intensify the work of the operators,

allied to competition between job seekers, between new and old, more fierce. Hirigoyen (2005) states that in the face of the ghost of unemployment and the increase of psychological pressures, mainly related to management practices, fear became a determining factor and a permanent tension between the workers and their hierarchical level, with the risk of losing everything at any time and being fired if it is not considered productive or adapted.

The workers are coerced to obtain great results in their individual evaluations and fulfillment of goals, constant overcoming, with this creates in the organization a climate of competitiveness and rivalry between them. Dejourns (2007) believes that this competitiveness and competition, when associated with the threat of unemployment, provokes radical changes in social relations in the work environment.

PUBLIC CIVIL ACTION AND THE PUBLIC MINISTRY OF LABOR

The performance and institutional function of the Public Prosecutor's Office (PPO) is foreseen in the 1988 Constitution, Articles 127 to 129, as well as Complementary Law 75/1993 in articles 83 to 85.

In Articles 83 to 84 of Supplementary Law 75/1993, it has, besides the competence of the Public Prosecutor's Office, a non-exhaustive list of the attributions of the same to the organs of Labor Justice, since it is extensive, in view of the provisions also in articles 6 to 8°.

Among other functions of the Public Prosecutor's Office foreseen in art. 129 of the Federal Constitution and art. 83 of Complementary Law 75/93 is to promote the Public Civil Action (PCA), to defend collective interests, when disrespected the constitutionally guaranteed social rights.

The public civil action can be promoted by the PPO based on denunciations of the unions of the categories to defend workers' individual and social interests, the environment of the work or the condition of its associates, affected by the noncompliance with the law on working conditions, when not resolved administratively between the PPO and the company.

The public civil action is used by the PPO in the defense of diffuse and collective interests, according to what is foreseen in art. 129, item III of the Federal Constitution and Complementary Law 75/1993, which aims to fulfill the obligation to do or not do, in order to restore the injury to the diffuse, collective or individual right.

To Milk (2010, p. 1201) the civil action "may have preventive or reparatory, damning, constitutive,

declaratory or writ, given that its object is always the protection of any diffuse interest, collective or homogeneous individual."

In the case of compensation for collective moral damages, the conviction of the company that did not comply with the law on working conditions is particular. Zanetti (2009, p. 97) states that the character of the penalty is reparation and that reparation is "intended for a third party who suffered nothing and had no bond with the aggressor."

When the damage or injury can not be remedied, compensation is sought in pecunia. This compensation for the conviction is not directed directly to the injured workers, but to a specific fund, which in most of the decisions are issued to the Workers' Assistance Fund (WAF), the Fund for the Defense of Diffuse Rights (FDR), Cancer Hospital or some nonprofit entity in the county or state.

Usually these convictions are of exacerbated values with the sole intention that condemnation serves as an example for society as a way to prevent further unlawful conduct, for both a convicted company and other companies. Usually has a "pedagogical", in some situations has a punitive function, to inhibit the practice, or to end the omission, in other words, it is a question of penalizing in the future not to repeat such conduct again.

In the legislation there is no clear definition of the destination of the condemnation values, and can be reverted to a non-profit institution of the state or municipality, being at the discretion of the judge. Araújo Maltz (2013) opposes the allocation of the values of corporate conviction to the FAT, since it understands that pecuniary compensation as collective moral damages should be assigned to the affected community and when the indemnity goes to the FAT, it is not effectively therefore does not occur fairly and efficiently. When the pecuniary portion is directed to the FAT, the condemnation imposed on the offender is not reverted to the affected collective, on a motorcycle that the injured assets and interests are not repaired.

III. METHODOLOGICAL PROCEDURES

To better understand the criteria used in this exploratory research that according to Martins e Silva (2005) constitutes an attePPO to describe and make predictions through information obtained in the research, and are intended to provide support to support the theory or not.

The methodological procedures that were used are described in Table 1, indicating the typology for the theoretical-empirical investigation of the research:

Table 1: description of methodological procedures

Procedures	Description
Field of Science	It is an applied social research, belonging to the field of interdisciplinary science between administration and law.
Bibliographic research	Study of publications dealing with the problem of moral harassment, particularly those works that address different aspects of the phenomenon, and the legal issue.
Documentary research	Analysis of the current legal and infralegal legislation, which may frame the conduct of organizational moral harassment; on-line documentary analysis of sentences handed down by the 24 TRTs.
Research on the Internet	Quantitative and qualitative data referring to the pertinent sentences, proclaimed by the 24 TRTs, through the site http://login.advisebrasil.com.br/liber accessed from May 9, 2016, from 2006 to 2016.
Qualitative research	The qualitative approach aims to understand and interpret elements, motivations, non-quantifiable behaviors.
Quantitative research	The approach aims to identify the quantification of the information collected.
Data analysis	Analysis and interpretation of the quantitative and qualitative data collected regarding the recording of phenomena and observation of the object.

Source: Elaborated by the authors

In this article the methodological procedures are divided into two stages: in the first stage, the judgments judged in the second instance were analyzed on the practice of aggressive management by moral harassment, limiting the study to the period from 2006 to 2016, shown in Table 2, and the second the analysis of the data obtained:

Table 2: Summary of the technique used in sentence analysis

DISCRIMINATION	DESCRIPTION
TECHNIQUE	THE TERM SOUGHT IN THE SENTENCES WERE "ORGANIZATIONAL MORAL HARASSMENT" OR "COLLECTIVE HARASSMENT", "PUBLIC CIVIL ACTION"
REASONS FOR THE CHOICES	THE JUDGMENTS THAT EXPLICITLY PRESENTED THE SEARCHED TERMS WERE CHOSEN, AT THE INITIATIVE OF THE PUBLIC PROSECUTOR'S OFFICE FOR DENUNCIATION OR INITIATIVE ACTIONS OF THE UNIONS OF THE CATEGORIES, WHICH WERE DIRECTLY RELATED TO THE STUDY.
CLASSIFICATION OF SENTENCES	EACH SENTENCE CONTAINING THE TERMS WAS READ, CHECKED THE VALUE OF THE CONVICTION, TYPE OF MANAGEMENT PRACTICED, THE REGION AND THE IDENTIFICATION OF THE CONVICTED COMPANY, AND RECIDIVISM.

Source: Elaborated by the authors

IV. DATA ANALYSIS AND RESULTS

Of a total of 51 actions published on the site of initiative of the Public Prosecutor's Office, by denunciation or initiative actions of the unions of the category, which had direct relation with the focus of this study "organizational moral harassment or" collective harassment ", " public civil action. "

Of the total number of judgments analyzed in the second degree, four were considered unfounded and 47 were considered proceeds. Of the judgments analyzed, the companies appealed to higher courts, and two (2)% of the sentences were amended with a reduction in value, while maintaining the conviction, and the other sentences were maintained, with a "pedagogical-punitive" character.

From the judgments considered appropriate, the convictions have values considered high, by the practice of aggressive management, shown next in Table 3:

Table 3: Convictions imposed on companies that practice organizational moral harassment

DATE	COMPANY	STATE	VALUE
2016	BANCO BRADESCO	RN	1.000.000,00
2016	BANCO BRADESCO E O	AL	5.000.000,00

	BRADESCO VIDA E PREVIDÊNCIA		
2016	HSBC BANK BRASIL S.A	RJ	3.000.000,00
2016	SATTE ALAM VEÍCULOS E PEÇAS LTDA	RS	50.000,00
2016	PETRO ITA TRANSPORTES COLETIVOS DE PASSAGEIROS LTDA	RJ	100.000,00
2016	RANDON S/A IMPLEMENTOS E PARTICIPAÇÃO S, FRAS-LE S/A E SUSPENSYS SISTEMAS AUTOMOTIVOS LTDA	RS	200.000,00
2015	BARRY CALLEBAUT	BA	500.000,00
2015	SBF COMÉRCIO DE PRODUTOS ESPORTIVOS LTDA, DETENTORA DAS LOJAS CENTAURO	MG	300.000,00
2015	ESCRITÓRIO DE ADVOCACIA CARLOS TRANCOSO, NAZA PEREIRA E ASSOCIADOS	RO	400.000,00
2015	BANCO DO BRASIL	DF/TO	600.000,00
2015	PROSEGUR BRASIL S.A. - TRANSPORTAD ORA DE VALORES E SEGURANÇA	RN	700.000,00
2015	HOSPITAL SARAH	MA	300.000,00
2015	AMBEV	AL	150.000,00

2015	EMPRESA BRASILEIRA DE CORREIOS E TELÉGRAFOS (ECT)	DF	1.000.000,00
2015	COMPANHIA PAULISTA DE FORÇA E LUZ E A COMPANHIA PIRATININGA DE FORÇA DE LUZ, DO GRUPO CPFL	SP	12.000.000,00
2015	BANCO SANTANDER S/A	RJ	500.000,00 + UM salário mínimo a cada substituído
2014	BANCO SANTANDER S/A	AL	400.000,00
2014	LINKNET TECNOLOGIA E TELECOMUNICAÇÕES	DF	2.000.000,00
2014	CALCADA EMPREENDIMENTOS IMOBILIARIOS S/A	RJ	5.000.000,00
2014	ATENTO BRASIL S.A. - EMPRESA QUE ATUA NO SETOR DE TELEMARKETING E CALL CENTER -	DF/TO	1.000.000,00
2014	LOJAS CITY LAR	AC	500.000,00
2014	LOJA DA RIACHUELO	AL	10.000.000,00
2014	CARREFOUR	PB	1.000.000,00
2014	BANCO DO BRASIL	BA	2.000.000,00
2014	KUEHNE+NAGEL SERVICOS LOGISTICOS LTDA., TRANSEICH ASSESSORIA E TRANSPORTES		45.000,00

	S/A		
2014	EMPRESA OI - 14 BRASIL TELECOM CELULAR S/A	RO	325.000,00
2013	GRUPO JBS	MT	9.000.000,00
2013	VIAÇÃO VERDUN S.A	RJ	1.000.000,00
2013	RICARDO ELETRO	ES	300.000,00
2013	HSBC BANK BRASIL S/A - BANCO MÚLTIPLO E O HSBC SERVIÇOS E PARTICIPAÇÕES LTDA.	RJ	2.500.000,00
2013	BRASIL KIRIN, DONA DAS MARCAS NOVA SCHIN E DEVISSA	SP	700.000,00
2012	CARREFOUR	DF	100.000,00
2012	AMBEV		50.000,00
2012	BANCO CENTRAL -		500.000,00
2012	ITAU	RJ	150.000,00
2011	SAMSUNG DO BRASIL	SP	10.000.000,00
2011	EMPRESA DE BEBIDAS RENOSA (ENGARRAFORA COCA COLA)	MT	300.000,00
2011	AMBEV	RJ	25.000,00
2011	WALMART	SP	140.000,00
2010	SAMSUNG	SP	10.000,00 por funcionário
2010	EXTRA HIPERMERCADO	MS	1.000.000,00
2010	RBS (AFILIADA REDE GLOBO NO RIO GRANDE DO SUL)	RS	300.000,00
2010	BANCO DA AMAZÔNIA S/A	SP	10.000.000,00

2009	AMBEV- COMPANHIA DE BEBIDAS DAS AMÉRICAS	MG	1.000.000,00
2008	UNIBANCO	RS	50.000,00
2006	AMBEV — COMPANHIA BRASILEIRA DE BEBIDAS	RN	1.000.000,00
2006	AMBEV	RS	1.000.000,00

Source: Elaborated by the authors

Analyzing the sentences that have been issued, it can be seen that the convicted companies extrapolated the executive power of the employer, either by action as a practice and management philosophy, or by omission for not restraining the action of the managers of their managers.

In the sentences it is verified that 99% of the companies were condemned by several practices of organizational moral harassment, as shown in Table 4 below:

Table 4: Harassment practices that led to corporate conviction

TYPE OF HARASSMENT	AMOUNT
The use of slang words when addressing employees, shouts, name-calling, pejorative nicknames such as "Neanderthal", "imbecile", "incompetent", "tabajara administrator", "dumb college", "idiot idiot" "you're a bitch?", "troublemaker", "credit freak", slow, incompetent	22
Prejudice. "Ugly and stinky people"	1
Remuneration based exclusively on commissions to force to achieve goals, abusive demands to achieve goals	15
Public harassment and ridicule, such as "wearing t-shirts with derogatory phrases", "threatened with dismissal," were forced to "lie in a coffin" (which represented a dead professional), or forced to "dance alone" doing push-ups "in front of the others," wearing diapers, wearing skirt, helmet with ox horns, colored wigs, lipstick.	15
Vexatious situations when the worker who did not meet the so-called "wrestling" goals were forced to serve pizza, in waiter's clothes, to other employees who were able to achieve the goals and received the title of "full ball", and subjected to degrading situations	7

The performance of services for which they are not qualified or short of their qualification, determination of removal of trash and loading buckets of water after working hours to carry out cleaning the next day.	
Vexatious situations with objects: "turtle trophy" and "lantern trophy", "hanged rats and chickens" that were left on the tables or in the boardroom	2
The most productive were "rewarded" being forced to participate in festivals on farms with prostitutes, received "prostitute tickets", and those who even being more productive, religious and did not want to participate were tied and forced to watch porn movie and witness " strip-teases.	1
Striking retaliation to strikers, decommissioning as a form of punishment for filing a lawsuit, preventing participation in strikes under threat of dismissal, thus preventing the fight for better wages and working conditions	3
Racial and aesthetic (with obese workers) discrimination, to the point of forcing the worker to lose weight saying that "customer does not like sloppy, fat person."	4
Preventing the hiring of an indebted worker	1
Isolation of an HIV-positive employee, homophobic offenses such as "had a gay voice", "homeless kid."	2
Pregnant women in several of these companies became the main victims, interfering with the maternity leave of the maid days after delivery, pregnant women forced to stay in isolated rooms of other employees, without performing any assignment, in places with little ventilation and with distant toilets, with threats of dismissal after the legal deadline for return to activities and pregnant women coerced and suffered on board due to pressure.	4
Forced to work even sick, for fear of being fired, were constantly threatened with dismissal without just cause, to force the worker to accept contractual changes regarding the work day.	7
Reprimands with false motives, unmotivated or disproportionate to the misconduct, use of subterfuges in order to find flaws in the work of employees, unmotivated threats of dismissals, reprisals against those who did not comply with their treatment.	2
Persecution of workers with dissemination of inquiries, disciplinary administrative proceedings with unreasonable lengths on old and even investigated allegations	3

Insertion of pornographic magazines into employee handbags and belongings, acts that result in invasion of privacy and intimacy of female employees, as well as sexual assault on female employees.	2
Failure to comply with labor legislation, long working hours, excessive work hours that lasted up to 14 hours a day, or strenuous work, not granting paid rest every six days, reassignment of holidays, fulfillment of several tasks with too little time, payment of extra hours off the pay stubs.	8
Forcing workers to formally show their intention to leave the company, Forcing the worker to resign, to get rid of the costs of termination.	2
Transfer to workers the risk of enterprise ventures	3
Prevent workers from "taking water or going to the bathroom," requiring supervisory approval so the worker can get up or go to the bathroom, impose pace and work system that required employees to dine and their physiological needs within vehicles strong car	3
Maintain working environment in unhealthy conditions, with the risk of contracting illnesses, risks of accidents at work, exposing workers to ammonia gas leakage, having lunch in a place without the minimum hygiene, exposed to insects from a dump, without personal protective equipment.	3
Employee isolation	3
Performing tasks above capacity or below capacity	4
Prevent communication between employees	2
Obliging employee to present the ICD (international classification of the disease) under threat of dismissal, discount of absences	1

Source: Elaborated by the authors

Analyzing the sentences that have been issued, it can be seen that the convicted companies extrapolated the directive power of the employer, either by action as a practice and management philosophy "management by stress, or by omission for not restraining the actions of those who exercise managerial positions, confirming the research done by Heloani (2004).

It is clear the disrespect for the dignity of the human person, imbricated with individual and collective moral damage, as well as the social value of work, provided for in the Federal Constitution of 1988 in its article 1, items III and IV, when it is verified in the sentences humiliating and vexatious actions that were submitted to the employees.

It is observed that the adoption of policies of aggressive management with constant use by the managers and

managers of words of low slang when addressing the employees, shouts, curses, pejorative and prejudiced nicknames, reported and proven in the testimonies corroborate with the investigations of Soboll (2008) and Hirgoyen (2005).

It is noted in sentences the abusive demand to achieve goals. These goals are often unattainable, when the worker reaches them, new goals are established. The situations reported by the workers in the initial petitions and proven during the judicial process, corroborate the investigations carried out by Dejours (1987), Hirgoyen (2005), Soboll (2008) where in the group management the inhumane strategies for the collection of abusive and unreal goals.

The workers who did not reach the targets were subjected to discriminatory, humiliating situations and vexatious situations that had no limits. Even creating trophies and symbols that were exposed in the sense of shaming the workers, because they were exposed on the tables and in the meeting rooms.

No less vexatious were the prizes to the most productive ones who were forced to participate in parties in chambers with prostitutes, received "prostitute card", and accepted to participate, being tied and forced to watch pornographic film and to witness strip-teases.

It is noted in the statements evidences of retaliation against strikers, decommissioning as a form of punishment for filing a lawsuit, and forbidding employees to join strikes under threat of dismissal, thus preventing the fight for better wages and working conditions, hurting the fundamental and social rights provided for in articles 5 and 7 of the Federal Constitution.

In the research carried out in the sentences, the practice of harassment with women, homosexuals, blacks, obese, racial discrimination, regional, confirms previous studies by Freitas (2001).

The abuses of the directive power on the part of the companies with the intention to force the worker to resign are clear, in order to reduce the costs of the rescission. Harassment targeted at a specific group of workers, as in the case of pregnant women. These situations confirm the data found in the surveys of Freitas (2001), Hirgoyen (2005) and Guedes (2008).

Bankers reported and proved that they were forced to work even sick, for fear of being dismissed, were constantly threatened with dismissal without just cause, to force the worker to accept contractual changes regarding the work day, which corroborates the submission in the Eberle surveys, Soboll and Cremasco (2009).

Companies that used reprimands with false motives, unmotivated or disproportionate to the misconduct, use of

subterfuges in order to find flaws in the work of employees, unmotivated threats of dismissals, reprisals against those who did not comply with their treatment, even dissemination of disagreeable lengths over old and even investigated allegations. These behaviors used by companies are manipulation and domination, contribute to the emergence and maintenance of fear, anguish, which confirm the research done, by Eberle, Soboll and Cremasco (2009), Dejourn (1987), Hirigoyen (2005).

Constraints with intimate magazine on employee handbags and belongings, acts that deal with invasion of privacy and the intimacy of the employees, as well as invested of sexual nature on the maids women, causing embarrassment in the work environment.

Failure to comply with labor legislation is highlighted by non-observance of breaks, long periods of working hours, excessive working hours that lasted up to 14 hours a day, or strenuous, non-granting of paid rest every six days, relocation of taking over various tasks with too little time, transferring employees, requiring employees to perform services for which they are not qualified or short of their qualification, incurring illegality in the exercise of the directive power, clearly demonstrate the intention to harm the rights of workers, frontally wounding the labor rights and the obligation to maintain a healthy environment guaranteed in the Federal Constitution.

In the protracted sentences, companies were convicted for preventing workers from "drinking water or going to the bathroom," for forcing employees to eat their meals and their physiological needs in the wrong place. By keeping their working environment in unhealthy conditions, with the risk of contracting illnesses, risk of accidents at work, exposing workers to ammonia gas leakage, having lunch in a place without the minimum hygiene, exposed to insects from a dump, without protective equipment. Situations already reported in the surveys of Barreto (2006), Dejourn (1987) and Hirigoyen (2005) in which workers submit for fear of unemployment.

The convicted companies inflicted on workers a veritable climate of horrors. In many sentences workers' testimonials were classified as "shocking".

In the statements of the workers, they verified the situation of collective harassment practiced by managers or managers, in which it was evidenced that they had full knowledge of the aggressive management and total connivance of the management of the company in the acts practiced.

In the judgments it clearly shows that companies have extrapolated the directive power, their regulatory power and direction of employee activities, allowing or

practicing management that goes against the fundamental and social rights present in the 1988 Constitution.

The convictions although with high values were proportional to the economic and financial situation of the company, which even punctuating-pedagogical, shows that for some companies has not had an effect, since they are repeat offenders, as is the case of AMBEV, which was condemned in six public civil actions in different states, and continues with the same abusive practice of collecting goals, and subjecting employees to vexatious and humiliating situations.

Other companies also had the repeated conduct of collective harassment, and were twice convicted as Banco Bradesco, Banco Santander, Banco do Brasil, Banco HSBC and others.

The fine in almost 95% of convictions, the amounts were reverted to the Workers' Assistance Fund (WAF) and the other amounts were reverted to the Fund for the Protection of Diffuse Rights (FDR) and the Nucleus for the Support of Childhood Cancer (NSCC).

Table captions appear centered above the table in upper and lower case letters. When referring to a table in the text, no abbreviation is used and "Table" is capitalized.

V. FINAL CONSIDERATIONS

The objective of this article was to show that the high cost of bullying has not prevented some companies from continuing in aggressive management, failing to achieve the pedagogical goal of inhibiting and preventing the practice of stress management

In the judgments it clearly shows that corporations have extrapolated the directive power, their regulatory power to govern the activities of the employees, permitting or practicing a management that contradicts the fundamental and social rights present in the 1988 Constitution.

The high cost of convictions has not inhibited the recurrence of crime by some companies, which have maintained abusive targeting practices, and continued to subject employees to vexatious, humiliating and disrespectful labor laws.

REFERENCES

- [1] ARAÚJO MALTZ, T. Formas Alternativas de Reparação ao Dano Moral. Revista Direito Unifacs - Debate Virtual, 2013, n. 157
- [2] ARENAS, M. V. dos S. Assédio moral e saúde no trabalho do servidor público do Judiciário: implicações psicossociais. 2013, 341f. Tese (Doutorado em Administração) – Programa de Pós-Graduação em

- Administração. Escola de Administração. Universidade Federal do Rio Grande do Sul, Porto Alegre, 2013.
- [3] BRASIL. Constituição da República Federativa do Brasil de 1988. Disponível em: <http://www.planalto.gov.br/ccivil_03/constituicao/constituicao.htm>. Acesso em: 08 jun 2016.
- [4] _____. Emenda Constitucional n. 45 de 30 de dezembro de 2004. Disponível em: <http://www.planalto.gov.br/ccivil_03/constituicao/Emendas/Emc/emc45.htm>. Acesso em: 04 de jun 2016.
- [5] _____. Lei complementar 75, de 20 de maio de 1993. Disponível em: <http://www.planalto.gov.br/ccivil_03/leis/lcp/lcp75.htm>. Acesso em: 10 jun 2016.
- [6] EBERLE, A. D. et al. Assédio moral organizacional: esclarecimentos conceituais e repercussões. In: GOSDAL, Thereza Cristina; SOBOLL, Lis Andrea Pereira (Org.). Assédio moral interpessoal e organizacional. São Paulo: LTr, 2009.
- [7] BARRETO, M. Violência, Saúde e Trabalho: uma jornada de humilhações. São Paulo: EDUC, 2006.
- [8] DEJOURS, C. A loucura do trabalho: estudo de psicopatologia do trabalho/Christophe Dejours. Tradução de Ana Isabel Paraguay e Lúcia Leal Ferreira. 5ª. Edição Ampliada. São Paulo: Cortez – Oboré, 1987.
- [9] DEJOURS, C. A banalização da injustiça social. Tradução de Luiz Alberto Monjardim. 7ª. edição. Rio de Janeiro: Fundação Getúlio Vargas, 2006.
- [10] DEJOURS, C. Psicodinâmica do trabalho na pós-modernidade. In: MENDES, Ana Magnólia; LIMA, Suzana Canez da Cruz; FACAS, Emílio Peres (orgs). Diálogos em psicodinâmicas do trabalho. Brasília: Paralelo, 2007.
- [11] EINARSEN, S. Harassment and bullying at work: a review of the Scandinavian approach. Aggression and violent behavior, vol. 5, n. 4.p. 379-401, 2000.
- [12] FREITAS, M. E. Assédio moral e assédio sexual: faces do poder perverso nas organizações. Revista de Administração de Empresas, São Paulo, v. 41, n. 02, p.08-19, / 2001.
- [13] GUEDES, M. N. Terror Psicológico no Trabalho. 3ª ed. São Paulo: LTr, 2008
- [14] HELOANI, R. Assédio Moral: um ensaio sobre a expropriação da dignidade no trabalho. Revista de Administração Eletrônica, São Paulo, v. 3, n. 1, Art. 10, jan./jun. 2004
- [15] HIRIGOYEN, M. Mal-estar no trabalho: redefinindo o assédio moral. 2ª ed. Rio de Janeiro: Bertrand Brasil, 2005.
- [16] LEITE, C. H. B. Curso de direito processual do trabalho. 8 ed. São Paulo: LTr, 2010.
- [17] MARTINS, G. A.; SILVA, R. B. C. Plataforma Teórica-Trabalhos do 3º e 4º Congressos USP de Controladoria e Contabilidade: um estudo bibliométrico. In: Congresso USP de Controladoria e Contabilidade, 5, São Paulo: 2005. Anais do Congresso USP de Controladoria e Contabilidade. São Paulo, 2005.
- [18] SOBOLL, L.A. P. Assédio moral/organizacional: uma análise da organização do trabalho. São Paulo: Casa do Psicólogo, 2008.
- [19] ZANETTI, F. A problemática da fixação do valor da reparação por dano moral. São Paulo: LTr, 2009.

An Approach to Lessen the Stresses in Flat Slab for Earthquake Zone IV

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Abstract— It has been examine from various findings that the stresses generated in the flat slab analysis, its intensity should lessen in order to provide stability to the structure. For this, four cases have been taken viz., simple flat slab providing shear wall at lift area, simple flat slab providing shear wall at lift area and at maximum stress location, flat slab with drop providing shear wall at lift area and flat slab with drop providing shear wall at lift area and at maximum stress location on G+11 multistoried residential building located at seismic Zone 4. Using response spectrum method with the help of analysis and design tool STAAD Pro V8i, to evaluate analysis parameters such as nodal displacement, shear forces in column, compressive and tensile stresses, storey drift, von mis stress along with principle stress values. The prime case is obtained in this work is Building Case B2 in terms of reducing the stress.

Keywords— Drop Panel, Equivalent Frame Method, Flat Slab, Response Spectrum Analysis, Shear Wall, Storey Drift.

I. INTRODUCTION

The demand of residential houses increased drastically day by day in constructional sector. The multistoried building should be economical and should have less building components for archi-structural point of view. For that flat slab construction would be preferred. The Flat Slab is a slab which does not have beam component and it directly transfers its load to the soil through vertical columns. Slabs are generally of two types which are R.C.C slab and Flat slab. If beam is present with slab then it is called R.C.C slab and if beam is not present then it called as flat slab. To need more headroom, flat slab is used in multistoried building to decrease the overall cost of building construction. Also, the construction process of flat slab is almost unsophisticated as compare to R.C.C slab. In flat slab the loading patterns is almost same as R.C.C slab but distribution of load is different in both slab. Generally Flat slab is distinguished on the basis of drop panel and column capital. The construction of flat slab is generally used with drop panel or column head and vice versa depends upon the loading condition. If loading is less, then simple flat slab is used, otherwise rest of three types of flat slab will be taken into account. If loading is much higher at the junction of column and slab, a shear phenomenon is occurred is called punching shear that will develop near the support due to occurrence of higher end moment.

The flat slab is mainly of four types:

1. Simple flat slab
2. Flat slab attached with drop
3. Flat slab attached with column capital
4. Flat slab attached with drop and column capital

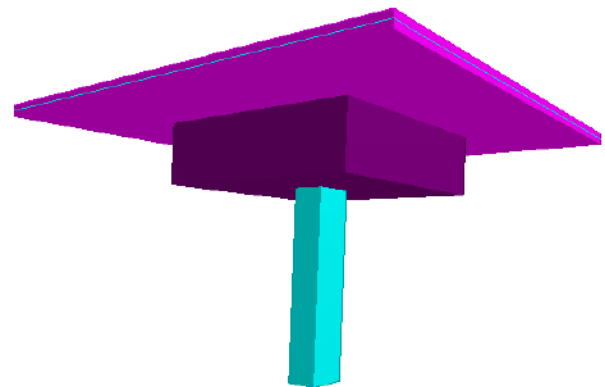


Fig. 1: Flat Slab

Drop - The Drop panel is supportive structural member of a flat slab which has provided with some thickness to the slab. It is attached at the junction of slab and column, it is always provided on bottom surface of the slab. The main purpose of providing drop in flat slab is to overcome the magnitude of moment near the support. The shape of drop should be in proper geometry i.e. rectangular or square according to the IS Code provisions.

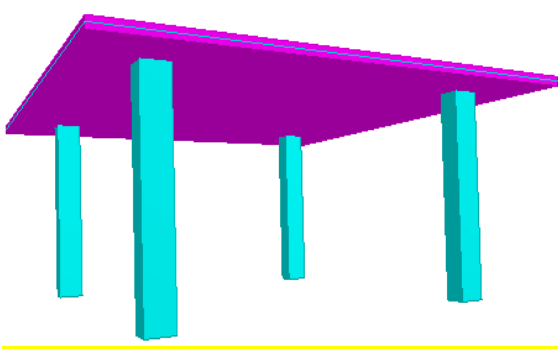


Fig. 2: Flat Slab with drop

Column head - Column head is the most important structural member of the flat slab, it reduces the punching shear effect on the critical section. It is monolithically constructed with column; also the diameter of the column capital is greater on the upper side of column. Various shape of column capital may be used in construction for architectural point of view.

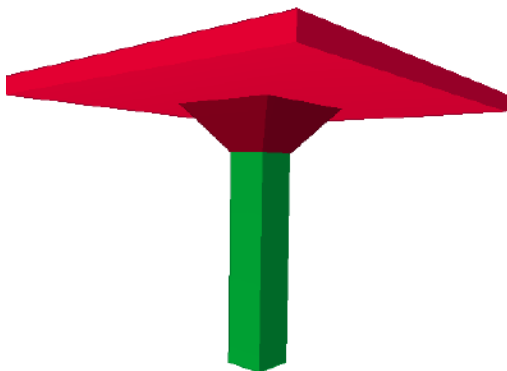


Fig. 3: Flat Slab with column capital

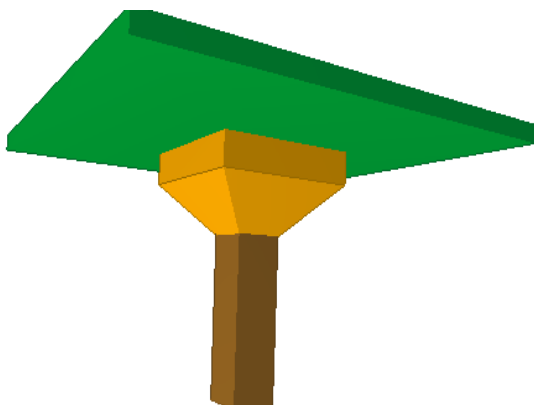


Fig. 4: Flat Slab with column capital and drop

II. OBJECTIVE

In this paper the main purpose is to find out the optimum Building Case of flat slab against lateral loading condition such as seismic loading. The structure is analyzed with response spectrum for seismic loading in STAAD Pro

software. After analyzing the different building plan and comparing all the result parameters which are as follows:

1. To find maximum nodal displacement in X and Z direction.
2. To evaluate the maximum value of axial force in column.
3. To find out maximum shear force in column in Sy and Sz direction.
4. To compare maximum compressive stress in column.
5. To evaluate maximum tensile stress in column.
6. To find maximum base shear in X and Z direction.
7. To compare storey drift in X and Z direction.

III. STRUCTURAL CONFIGURATION AND METHODOLOGY

In this research work the configuration used are as follows:

Table 1: Structural Parameters

Structural Parameters	Value
Plan area	25 m x 35 m
Building configuration	G+11
Over all height of building	45.72 m
Foundation depth	3 m
Height of each storey	3.81 m
Grade of concrete	M 30
Grade of steel	Fe-415
Diameter of bar	10 mm
Clear cover	20 mm
Unit weight of brick	19 KN/m ²
Thickness of external wall	0.203m
Thickness of internal wall	0.102 m
Plaster thickness	0.024 m
Unit weight of plaster	20 KN/m ²
Height of parapet	0.75 m
Unit weight of mortar	0.21 KN/m ²
Unit weight of clay tile	0.1 KN/m ²
Size of Column	(500x550) mm
Live load for roof	1.5 KN
Live load for floor	2.5 KN

IV. DESIGN OF FLAT SLAB

Table 2: Data considered

Given Parameters	Values
Panel size	(4x8) m
Drop depth	50 mm
Drop size	(1x2) m
Column size	(5x5.5) m
Column height	3.81m
Grade of concrete	M 30
Grade of steel	Fe-415

STEP 1- THICKNESS OF FLAT SLAB

Modification Factor (M.F) = 33.8
 Overall Depth (D) = Span / Ratio = 8000 / 33.8 = 236 mm,
 D with drop = 343 mm
 Effective Depth (d) = D - (Dia. of Bar / 2) - Clear Cover =
 343 - (10 / 2) - 20
 In Longer Direction (d_l) = 318 mm or .318 m
 In Shorter direction (d_s) = D_l - Dia. of Bar = 318 - 10 =
 308 mm or .308 m

STEP 2- LOAD CALCULATION

Dead Load

Self load of slab = D x unit weight of concrete = .343 x
 25 = 8.6 KN/m²

Plate area load = (thickness x height x unit weight of
 brick) / plate area

EWL = [(203x19+.024x20) x 3.81] / (8x4) = .51 KN/m²
for 10mm mortar both side of roof and floor = .42
 KN/m²

Clay floor tiles load = 12mm thick = .1 KN/m²

Total Dead Load = for floor level dead load =
 8.6+.51+.42+.1 = 9.62 KN/m²

Live load

For floor = 2.5 KN/m²

Total Load = for floor level = 9.62+2.5 = 12.12 KN/m²

Total Factored Load = for floor level = 1.5x12.12 = 18.19
 KN/m²

STEP 3- CALCULATION OF STIFFNESS AND ALPHA C (AC)

Along Longer Direction

For Slab

K_s = (4 x E x I) / LL = (4 x E x 1353117199) / 8000 =
 6766058 x E
 ∑k_s = 2 x 6766058 = 13532117

For Column

K_c = (4 x E x I) / CH = (4 x E x 2657812500) / 3810 =
 2790354 x E
 ∑k_c = 2 x 2790354 = 5580709
 A_c = ∑k_c / ∑k = (5580709E / 13532117 x E) = 0.41

Along Shorter Direction

For Slab

K_s = (4 x E x I) / LL = (4 x E x 27064234398) / 4000 =
 27064234 x E
 ∑k_s = 2 x 27064234 x E = 54128469

For Column

K_c = (4 x E x I) / CH = (4 x E x 1607812500) / 3810 =
 1687992 x E
 ∑k_c = 2 x 1687992 = 3375984
 A_c = ∑k_c / ∑k_s = 3375984 / 54128469 = .06

STEP 4- CHECK FOR CORRECTION DUE TO PATTERN LOADING

If Ratio Of Live Load And Dead Load Is Greater Than .5,
 Then Pattern Loading Required. Live Load /Dead Load <
 = .5

At Floor Level = live load / dead load = 2.5 / 9.62 = .25
 (not required)

STEP 5- TOTAL MOMENT CALCULATION

In Longer Direction

L_n = 7.55 m, L₂ = 4m, L_n² = 57.0025 m
 M_o = (W x L_n x L₂) / 8 or (w x L₂ x L_n²) / 8 = (18.19 x
 57.0025 x 4) / 8 = 518 KNm

In Shorter Direction

L_n = 3.65m, L₂ = 8m, L_n² = 13.32 m
 M_o = (W x L_n x L₁) / 8 or (w x L₁ x L_n²) / 8 = (18.19 x
 13.32 x 8) / 8 = 242 KNm

STEP 6- COLUMN STRIP AND MIDDLE STRIPS

In Longer Direction

Column Strips

2 (.25 x L₂) = 2 (.25 x 4000) = 2000 mm
 2 (.25 x L₁) = 2 (.25 x 8000) = 4000 mm
 Lesser Value Will Be Taken (A or B) Column Strip =
 2000 mm
 Middle Strips = L₂ - Column Strips = 4000 - 2000 = 2000
 mm

In Shorter Direction

Column Strips

2 (.25 x L₁) = 2 x (.25 x 8000) = 4000 mm
 2 (.25 x L₂) = 2 x (.25 x 4000) = 2000 mm
 Lesser Value Will Be Taken (A or B) Column Strip =
 2000 mm
 Middle Strips = L₁ - Column Strip = 8000-2000 = 6000
 mm

STEP 7- REINFORCEMENT

Along Longer Direction

Moment in Longer Direction

$$Pt \% = [50 * (fck/fy)] * 1 - \sqrt{1 - \left(\frac{4.6Mu}{fckbd^2}\right)}$$

Table 3: Reinforcement along Longer Direction

Mu	Mu _{cn} = .65 x .75 x Mo = .65 x .75 x 518 = 252	Mu _{cp} = .35 x .6 x Mo = .35 x .6 x 518 = 108	Mu _{mn} = .65 x Mo - Mu _{cn} = .65 x 518 - 252 = 84	Mu _{mp} = .35 x Mo x Mu _{cp} = .35 x 518 - 108 = 72
Pt	.37 %	.15 %	.07 % but take .12	.06 % but

			%	take .12 %
Total Ast	$(Pt \times b \times d) / 100 = (.37 \times 318 \times 2000) / 100 = 2360$	$(Pt \times b \times d) / 100 = (.15 \times 318 \times 2000) / 100 = 960$	$(Pt \times b \times d) / 100 = (.12 \times 318 \times 2000) / 100 = 770$	$(Pt \times b \times d) / 100 = (.12 \times 318 \times 2000) / 100 = 770$
Ast/m	1180	480	382	382

STEP 8- REINFORCEMENT ALONG SHORTER DIRECTION

For Roof

Table 4: Reinforcement along Shorter Direction

Mu	$Mu_{cn} = .65 \times .75 \times Mo = .65 \times 242 = 118$	$Mu_{cp} = .35 \times .6 \times Mo = .35 \times 242 = 51$	$Mu_{mn} = .65 \times Mo - Mu_{cn} = .65 \times 242 - 118 = 40$	$Mu_{np} = .35 \times Mo \times Mu_{cp} = .35 \times 242 - 51 = 34$
Pt	.17 %	.048 % but taken .12 %	.012 % but take .12 %	.010 % but take .12 %
Total Ast	$(Pt \times b \times d) / 100 = (.17 \times 308 \times 2000) / 100 = 1050$	$(Pt \times b \times d) / 100 = (.12 \times 308 \times 2000) / 100 = 740$	$(Pt \times b \times d) / 100 = (.12 \times 6000 \times 308) / 100 = 2222$	$(Pt \times b \times d) / 100 = (.12 \times 6000 \times 308) / 100 = 2222$
Ast/m	524	370	370	370

STEP 9- CHECK FOR TWO WAY SHEAR OR PUNCHING SHEAR

Shear Force Calculation

$V_u = (L_1 \times L_2 - \text{critical section area}) \times \text{factored load}$
 $= (8 \times 4 - .758 \times .658) 18.19 = 574 \text{ KN}$
 $Bo = 2 \times \text{critical section area} = (658 + 758) \times 2 = 28$
 $Bo \times d = 2834 \times 308 = 875047$
 $TAU_c = V_u / Bo \times d = (574 / 875047) \times 1000 = .65 \text{ N/mm}^2$
 From is code 456 -2000 page no. 58 (cl. 31.6.3.1)
 $K_s = 1.25$
 $tauc = .25 \times (f_{ck})^{.5} = 1.118$
 $tauc' = 1.118033989$, For Roof - $TAU_c = .65 \text{ N/mm}^2$.

V. SEISMIC LOADING DETAIL

For analysis of structure in seismic loading the provisions of IS code 1893 (2000) part 1, is preferred. The seismic parameters are listed in table below:

Table 5: Seismic Definitions

Zone factor	4
Response reduction factor	4 with SMRF with ordinary shear wall
Important factor	1 i.e. General Structure
Rock/soil types	Medium Soil
Types of structure	Flat Slab
Damping ratio	5 %
Fundamental natural period of vibration	.09 x h / (d) ^{0.5}

Load Combinations- The load combinations are used to analyze G+11 multistoried building which are followed by IS-1893. The main thirteen load combinations used in this work are as follows:

Table 6: Possible Load Combinations

S. No.	Load combination
1	1.5(DL + LL)
2	1.2(DL + LL + EQX)
3	1.2(DL + LL - EQX)
4	1.2(DL + LL + EQZ)
5	1.2(DL + LL - EQZ)
6	1.5(DL + EQX)
7	1.5(DL - EQX)
8	1.5(DL + EQZ)
9	1.5(DL - EQZ)
10	0.9DL + 1.5EQX
11	0.9DL - 1.5EQX
12	0.9DL + 1.5EQZ
13	0.9DL - 1.5EQZ

VI. CASES USED IN FLAT SLAB

In this work, there are four types of Building Cases that are considered after the review of literature and to be analyzed with STAAD Pro, the cases are follows:

Table 7: Building Case Description

Building Case B1	G+11 Flat Slab building providing shear wall at lift location.
Building Case B2	G+11 Flat Slab building providing shear wall at lift and maximum stress location.
Building Case B3	G+11 Flat Slab added drop building providing shear wall at lift location.
Building Case B4	G+11 Flat Slab added drop building providing shear wall at lift and maximum stress location.

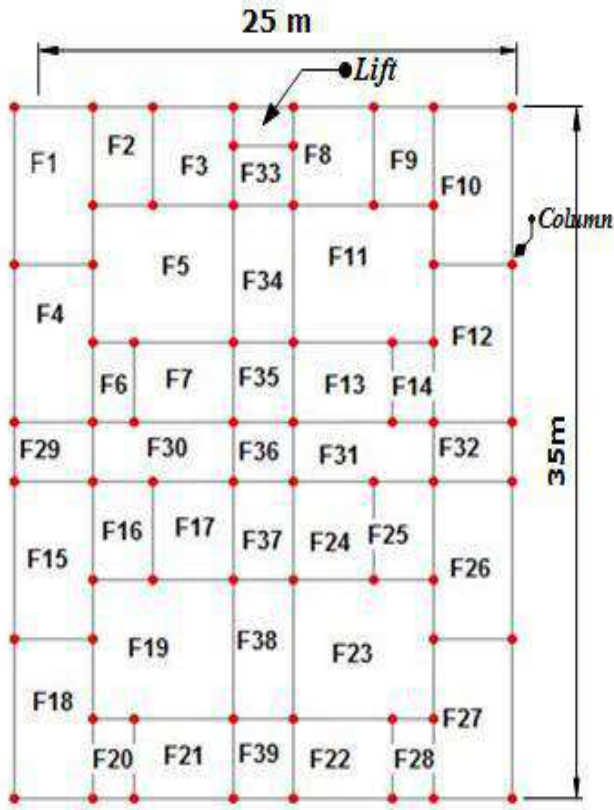


Fig. 5: Panel Layout in G+11 building

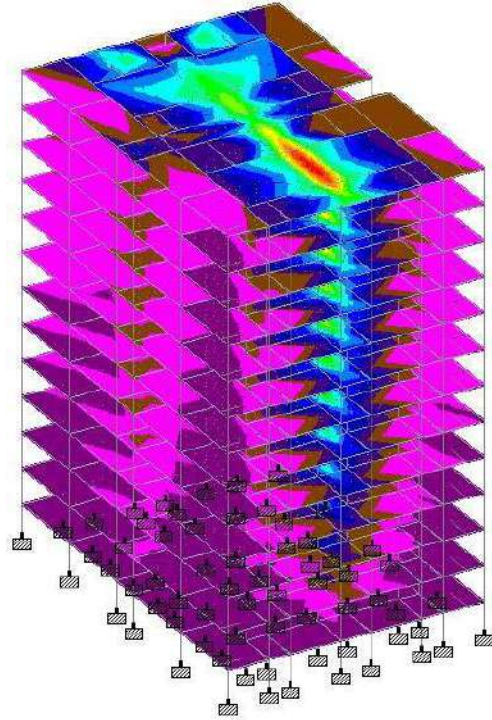


Fig. 7: Location of Maximum Stresses on plate

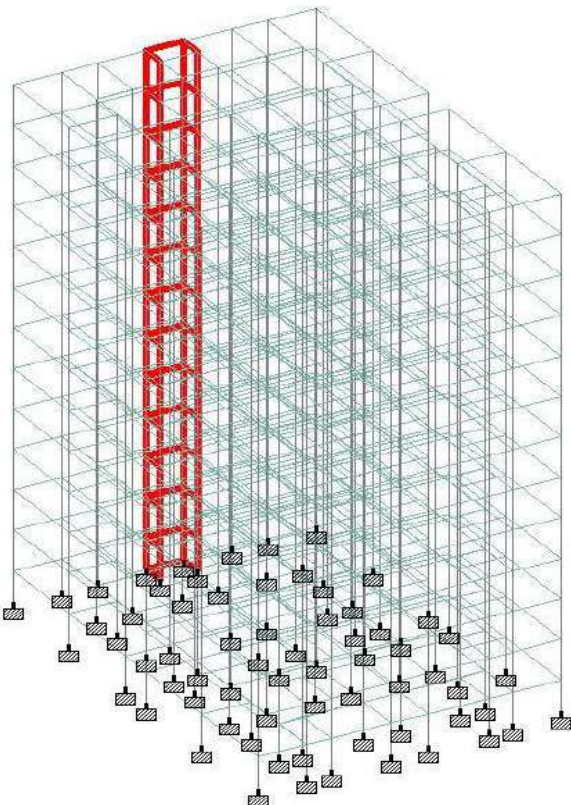


Fig. 6: 3D Wireframe view of Shear Wall provided at Lift Location

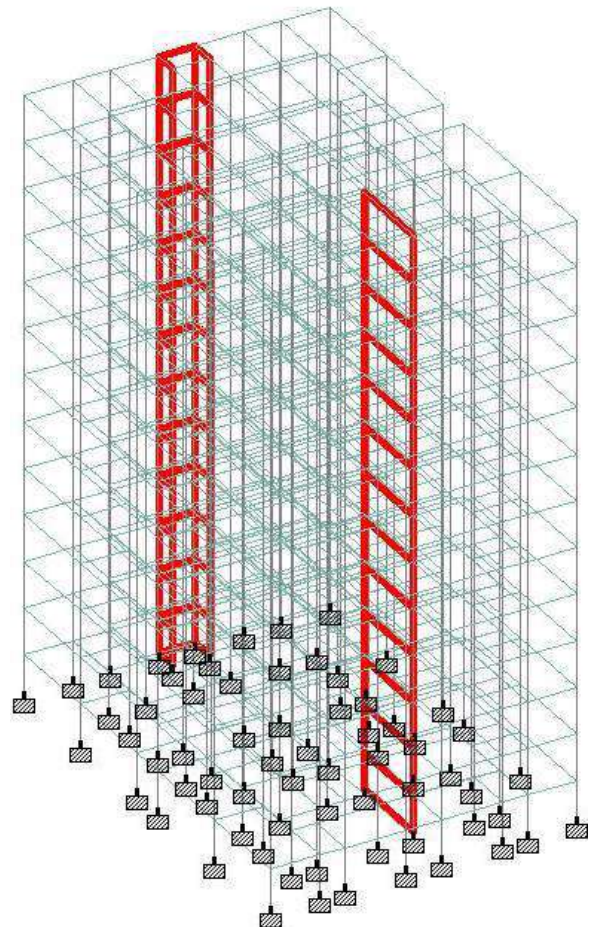


Fig. 8: Shear Wall provided over the maximum stressed location

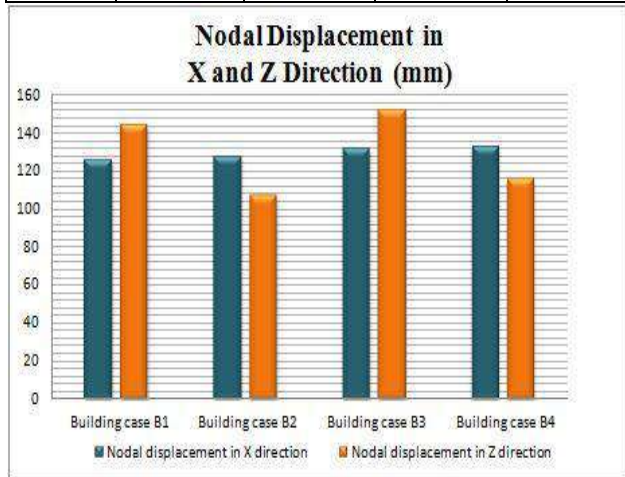
VII. RESULTS AND DISCUSSION

In this work, the four Building Cases in STAAD Pro are analyzed and compared. All parametric results to find out optimum Building Case are as follows:-

Nodal displacement in X and Z Direction

Table 8: Nodal displacement in X and Z Direction

Cases	Maximum Displacement In X and Z Direction (mm)			
	Building Case B1	Building Case B2	Building Case B3	Building Case B4
X Direction	125.959	127.686	131.601	133.058
Z Direction	144.473	107.322	152.065	115.89



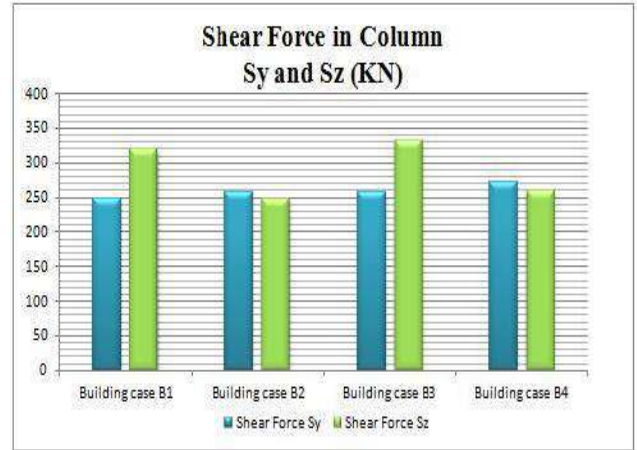
Graph 1: Nodal Displacement in X and Z Direction

The value of Nodal Displacement is minimum in Building Case B2 when observing the least values in both the directions. After comparing all the model cases, model case B2 shows the least values among all.

Shear Force in Column Sy and Sz

Table 9: Shear Force Sy and Sz in Column

Cases	Shear Force Sy and Sz in Column (KN)			
	Building Case B1	Building Case B2	Building Case B3	Building Case B4
Sy	248.685	257.545	258.512	270.955
Sz	319.728	249.878	333.374	260.203



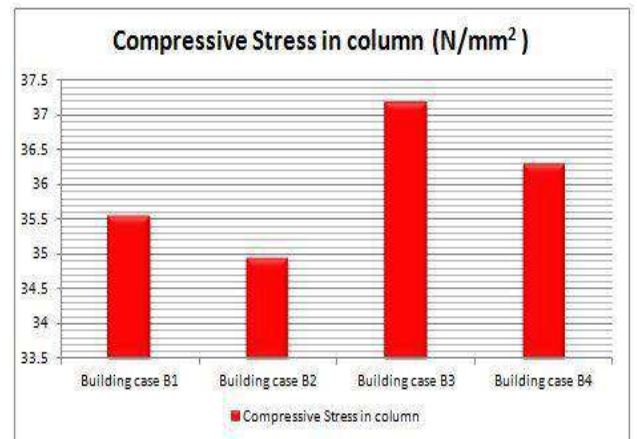
Graph 2: Shear Force in Column

On comparing the shear force values in column, for Y direction Building Case B1 shows the least value and for Z direction, Building Case B2 shows least value among all the considered cases. Since deciding the least value case, for this building plan for both the directions, Building Case B2 should be considered as least one.

Maximum Compressive Stress in Column

Table 10: Maximum Compressive Stress in Column

Cases	Maximum Compressive Stress in column (N/mm ²)			
	Building Case B1	Building Case B2	Building Case B3	Building Case B4
	35.54	34.945	37.171	36.293



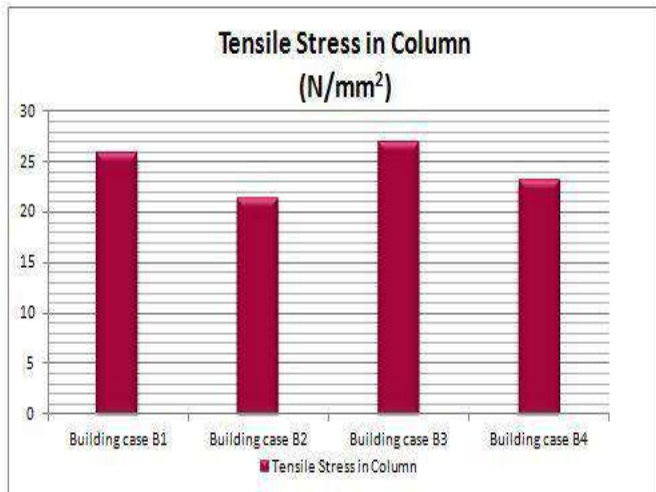
Graph 3: Maximum Compressive Stress in Column

Compressive Stress in Column is lesser among all Building Cases with a minimum value of 34.945 N/mm². So that Building Case B2 is optimum case.

Maximum Tensile Stress in Column

Table 11: Maximum Tensile Stress in Column

Cases	Maximum Tensile stress in column (N/mm ²)			
	Building Case B1	Building Case B2	Building Case B3	Building Case B4
	25.777	21.429	26.889	23.23



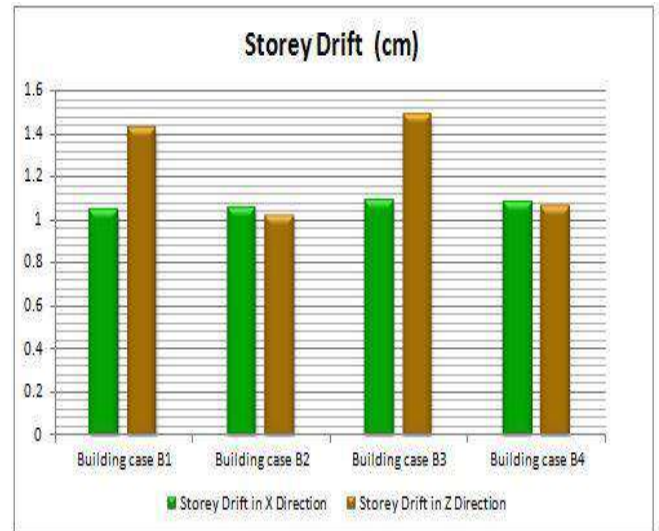
Graph 4: Maximum Tensile Stress in Column

To check and compare the maximum values of tensile stresses in four Building Cases, optimum Building Case obtained is B2 with a minimum value of 21.429 N/mm². Hence for this parameter, Building Case B2 should be considered.

Storey Drift in X and Z Direction

Table 12: Storey Drift in X and Z Direction

Cases	Storey Drift in X and Z Direction (cm)			
	Building Case B1	Building Case B2	Building Case B3	Building Case B4
X Direction	1.0458	1.0548	1.0909	1.0872
Z Direction	1.4294	1.0247	1.4894	1.0688



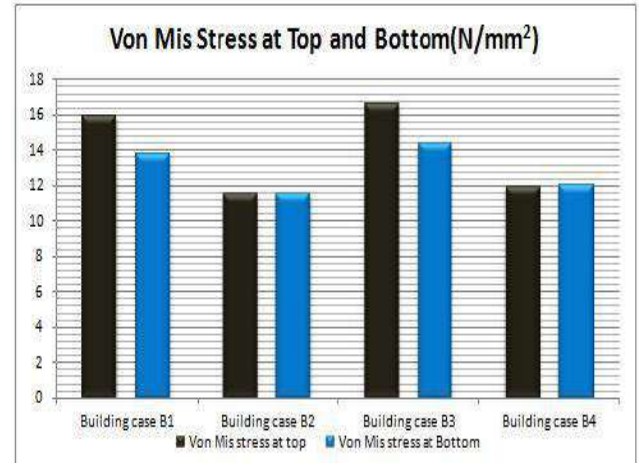
Graph 5: Storey Drift in X and Z Direction

Observing the Storey Drift parameter for X direction there is a minute difference in Building Case B1 and B2. But in Z direction, the observation clearly state that the Building Case B2 is an optimum case with a minimum value of 1.0247 cm. Hence the efficient case will be Building Case B2.

Von Mis Stress at Top and Bottom

Table 13: Von Mis Stress at Top and Bottom

Cases	Von Mis Stress at Top and Bottom (N/mm ²)			
	Building Case B1	Building Case B2	Building Case B3	Building Case B4
Top	15.955	11.548	16.603	11.976
Bottom	13.836	11.559	14.401	12.070



Graph 6: Von Mis Stress at Top and Bottom

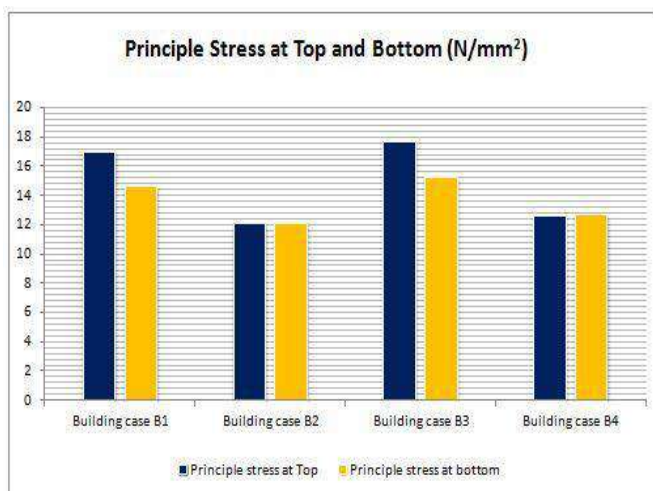
Building Case B2, on observing the graphical representation of the obtained values seems to be minimum among all Building Cases. Hence the efficient Building Case is Building Case B2 with a minimum

values of 11.548 N/mm² and 11.559 N/mm² for von mis top and bottom values.

Principle Stress at Top and Bottom

Table 14: Principle Stress at Top and Bottom

Cases	Principle Stress at Top and Bottom (N/mm ²)			
	Building Case B1	Building Case B2	Building Case B3	Building Case B4
Top	16.942	12.057	17.633	12.506
Bottom	14.620	12.070	15.219	12.599



Graph 7: Principle Stress at Top and Bottom

It is clearly observed that for multistory building situated in Seismic Zone IV, the Building Case B2 seems to be minimum for principle stresses top and bottom and proves to be an efficient case.

VIII. CONCLUSION

After analysis of various parameters that are evolved for four different Building Cases, the conclusion obtained by summarizing result parameters are as follows:-

1. Building Case B2 is an optimum Building Case in terms of nodal displacement in X and Z direction showing its minimum value of 127.686 mm and 107.322 mm respectively.
2. Finding and Examine the Compressive stress in column seems to be less among all Building Cases with a minimum value of 34.945 N/mm². So that Building Case B2 is optimum Building Case.
3. After checking and comparing the maximum values of tensile stresses in four Building Cases, optimum Building Case obtained is B2 with a minimum value of 21.429 N/mm². Hence for this parameter, Building Case B2 should be considered.
4. Observing the storey drift parameter, for X direction there is a minute difference in Building Case B1 and B2. But in Z direction, the observation clearly state

that the Building Case B2 is an optimum case with a minimum value of 1.0247 cm. Hence the efficient case will be Building Case B2.

5. On examine the Building Case B2, on observing the graphical representation of the obtained values seems to be minimum among all Building Cases. Hence the efficient Building Case is Building Case B2 with a minimum values of 11.548 N/mm² and 11.559 N/mm² for von mis top and bottom values.
6. To explore the possibilities for multistory building situated in seismic zone 4, the Building Case B2 seems to be minimum for principle stresses top and bottom and proves to be an efficient case.
7. Concluding the research work, Building Case B2 should be preferred in terms of comparative results of various parameters.

IX. ACKNOWLEDGEMENT

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REFERENCES

- [1] Amit Asathawane, R. S. Deotale (2012), "Analysis of Flat Slab and Grid Slab And Their Cost Comparison" International Journal of Advanced Technology in Civil Engineering, ISSN: 2231-5721, Vol. 01, Issue 02, pp. 122-126.
- [2] Anuja Walvekar, H.S Jadhav, (2015), "Parametric Study of Flat Slab Building Without or With Shear Wall to Seismic Performance", International Journal of Research In Engineering, ISSN: 2319-1163, Vol. 04, Issue 04, pp. 601-607.
- [3] Dr. Uttamasha Gupta, Shruti Ratnaparkhe, (2012), "Seismic Behaviour of Building Having Flat Slab With Drop", International Journal of Emerging Technology and Advanced Engineering, ISSN: 2250-2459 ,Vol. 02, Issue 10, pp. 416-421.
- [4] Kaulkhere R.V, Prof. G.N Shete, (2017), "Analysis and Design of Flat Slab With Various Shape", International Journal of Scientific Research and Development, ISSN: 2455-2631, Vol. 02, Issue 05, pp. 538-544.
- [5] Miguel Fernandez, Aurelio Muttoni and Jakob Kunz, (2010), "Strengthening of Flat Slab Against Punching Shear using Post Installed Shear Reinforced", ACI Structural Journal, Title No.107-S43, Vol.107, Issue 4, pp. 434-442.
- [6] Moh. Imran, M. Visweswara, Dr. Jammi Ashok (2017), "A Comparative Study of Flat Slab Vs Post Tensioned Flat Slab", International Journal of Scientific Research and Development, ISSN: 2321-0613 ,Vol. 05, Issue 09, p.p. 979-982.

- [7] M.K. Devtale , S.S. Sayyed, Y.U. Kulkurni, P.G. Chandak, (2016), “Comparission of Seismic Response Between Flat Slab Vs Regular Frame Building” International Journal of Advancement In Engineering Technology, Management and Applied Science, ISSN: 2349 - 3224 ,Vol. 03, Issue 06, p.p. 104-111.
- [8] Nasr. Z Hussan , Mostafa A. Osman (2017), “Enhancement of Punching Shear Strength of Flat Slab Using Shear Bond Reinforcement”Housing and Building National Research Center, p.p. 1-7.
- [9] P. Manjunath, Yogendra R. Holebsgilu, (2016), “Seismic Analysis of Multi Storied Building With Flat Slab Resting On Plain and Sloping Ground” Bonfring International Journal of Machine Interface ,ISSN: 2277-5064 ,Vol. 4, Issue Special, pp.20-25.
- [10] P. Srinivasulu and A.Dattatreya Kumar (2015), “Behaviour Of Rcc Flat Slab Under Earthquake Loading”, International Journal Of Science And Research, ISSN: 2277-2685,Vol. 05, Issue 07, p.p. 821-829.
- [11] R.S. More And V.S. Sawant (2015), “Analysis of Flat Slab” international journal of science and research , ISSN: 2319-7064 , Vol. 04, Issue 07 , p.p. 98-101.

Effects of the Alcohol: A Review

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Abstract— *The alcohol beverages consumption by humanity is a common fact in a large number of cultures, for different purposes. Due to a high level of ethanol ingestion in many countries, and this relation about health and social problems, it is an issue which deserves special cautious. Alcohol metabolism can be made in three different ways. However, Enzymatic System of Alcohol Dehydrogenase (ADH) is considered the main one. This review will treat about nutritional aspects, which can cause undernutrition, vitamins and minerals deficits; endocrine-metabolic diseases, like diabetes mellitus and metabolic syndrome; Liver damage, such as steatosis, acute alcoholic hepatitis, a chronic alcoholic liver disease that causes cirrhosis and hepatic fibrosis, these manifestations can lead a hepatocarcinoma as well. Moreover, neurologic issues that can cause mood and behavior disorders, some examples of these problems are changes in synaptic transmission and neuronal excitability, anxiety and depression, attention deficit hyperactivity disorder, obsessions and compulsions, schizophrenic psychosis, affective disorders, insomnia, antisocial behavior, and suicide. It can also cause dependence with strong manifestations of abstinence.*

Keywords— *alcohol, metabolism, hepatopathy, nervous system.*

I. INTRODUCTION

Evidence and historical accounts reveal that alcohol intake dated back to prehistory and was part of the culture of many ancient societies. For the Egyptians, wine and beer, for example, were part of their daily lives. As for Greek society, alcohol was a fundamental item amongst them, and its abstinence was highly rejected, just as in the Roman empire, where the alcoholic beverage was also present in several activities. The profile of alcohol consumption remains to this day in different populations and at different ages (Robinson and Adinoff, 2016).

Currently, alcoholism is a health problem in Brazil and all over the world, as every year about 2.5 million people die from the use of this substance and

320,000 of these people are between the ages of 15 and 29 (Pavlov et al, 2016; Pavlov et al, 2016). The causes of death are related both to problems in the body and the increased risk of accidents and fatal cases of violence. Reflections on alcohol use in health vary according to genetic and environmental factors and how this substance was consumed. It is estimated that today 20% of men and 10% of women consume alcohol abusively (Robinson and Adinoff, 2016; Miquel et al, 2016; Testino et al, 2016; Preuss et al, 2017; Orywal et al, 2017).

Because of the numerous effects that alcohol can exert on the body, this study aims to review the relationship between alcohol consumption and its effects on the human body.

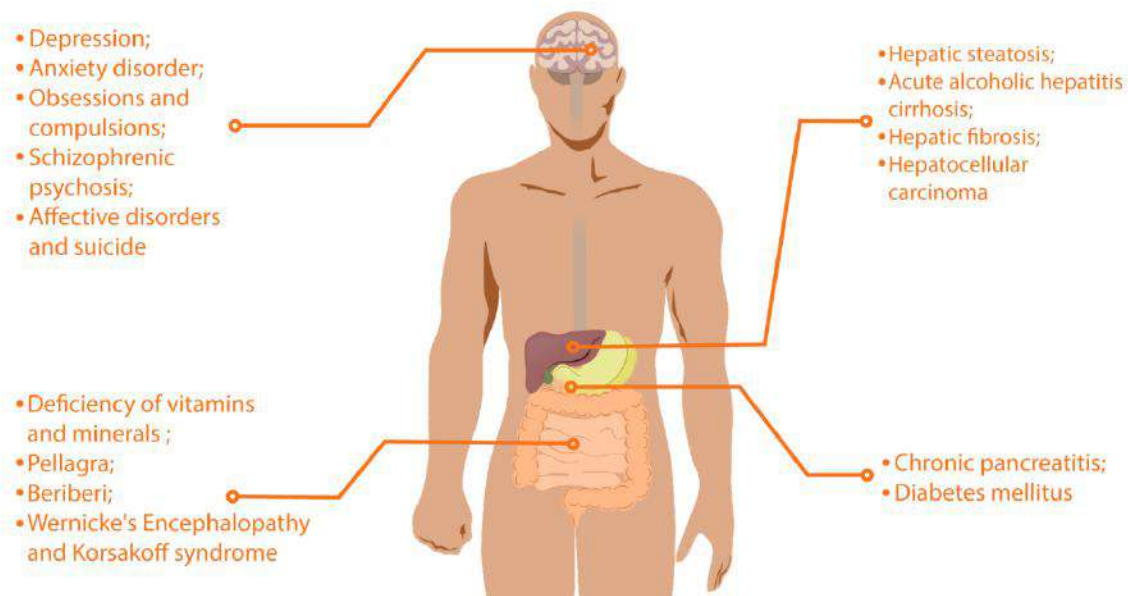


Fig.1: Manly effects of ethanol consumption. Issues neuropsychic related. Clinical branch of alcoholic liver disease. Gastrointestinal damages, vitamins, and nutrients absorption problems. Pancreas disturb and the relation with protein, sugar, and fat metabolism.

II. METHODS

This literature review was based on articles collected in the following platforms of bibliographic data: Pubmed, PMC, Medline, Lilacs, and Scielo. The selected articles were the ones published in the last three years, written in English, Portuguese, Spanish, and French. The retrospective search was restricted to indexed scientific articles describing research involving human and animals.

III. DISCUSSION

Alcohol Metabolization

Alcohol is absorbed by the gastrointestinal tract, and 2 to 10% of it suffer pulmonary and renal elimination; the rest is oxidized by the organism. There are three metabolic pathways for the ethanol: the Enzymatic System of Alcohol Dehydrogenase (ADH), whose enzymes are located in the cytosol of hepatocytes, the Microsomal Oxidation System of Ethanol (MEOS) and the Catalase in peroxisomes (Chi et al, 2016; Boye and Yang, 2016).

Through the ADH system, alcohol is transformed into acetaldehyde that enters the mitochondria, and it is oxidized by an enzyme called Aldehyde Dehydrogenase (ALDH) being transformed into acetate originating Acetyl-CoA, used as a substrate for the synthesis of ATP. When there is excessive consumption – or when there is some change in metabolism– an accumulation of acetaldehyde occurs – toxic to the tissues (Wall, Luczak, and Hiller-Sturmhöfel, 2016; Matejic, Gunter, and Ferrari, 2017; Dinis-Oliveira, 2016; Chang, Hsiao, and Chen, 2017). ALDH2 is the main responsible for the oxidation of acetaldehyde in mitochondria (Nene et al, 2017).

The microsomal ethanol oxidizing system (MEOS) oxidizes ethanol transforming into acetaldehyde by cytochrome P4502E1 or CYP2E1 (present in the endoplasmic reticulum of the liver and Catalase promotes oxidation with the aid of hydrogen peroxide(Chang, Hsiao, and Chen, 2017; Navarro and Navarro, 2013).

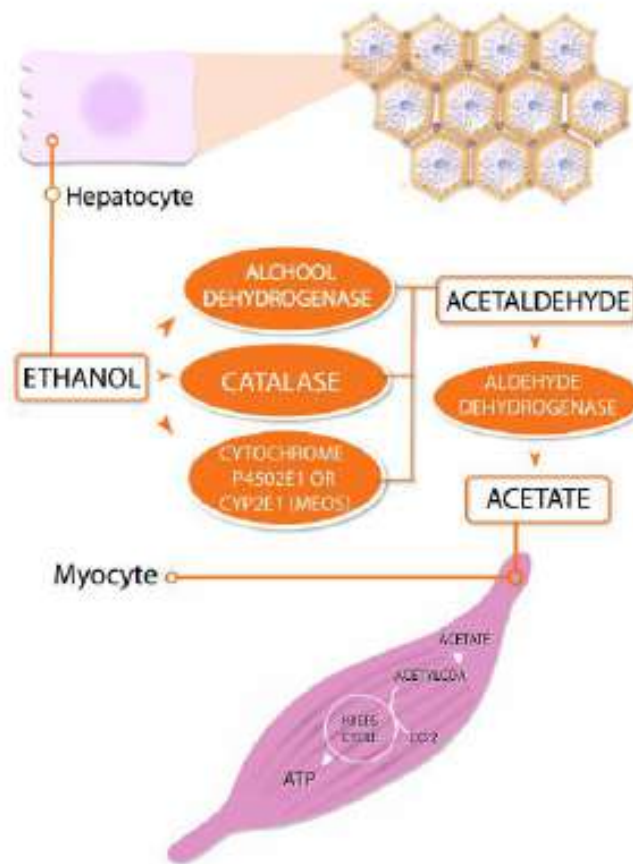


Fig.2: Ethanol metabolization, explaining the oxidation metabolism pathways, which are affected by Enzymatic System of Alcohol Dehydrogenase (ADH), whose enzymes are located in the cytosol of hepatocytes, the Microsomal Oxidation System of Ethanol (MEOS) and the Catalase in peroxisomes.

Alcohol and Nutritional Aspects

Alcohol possesses a large number of calories (7.1kcal/g). Consequently, there is a possibility of accumulation of fat and – paradoxically – malnutrition, which may be considered primary or secondary. The primary one is characterized by a nutritional deficit at the expense of a hypercaloric diet, but lacking macronutrients and vitamins. The secondary one, however, is described as intestinal malabsorption due to tissue injury (Barbosa and Ferreira, 2017; Barve et al, 2017; Sluik et al, 2017).

Malnutrition causes deficiency of vitamins and minerals, such as complex B, C, D and K, zinc, magnesium, and iron. This lack generates inefficiency of catabolic and anabolic pathways; oxidative stress; inflammatory processes; pellagra; beriberi; neurological lesions; mental confusion; ataxia; ophthalmoplegia and amnesia (Barve et al, 2017; Sluik et al, 2017).

Besides that, among the diseases caused by malnutrition and hypovitaminosis related to chronic ethanol consumption, we can cite Wernicke's Encephalopathy, which is a consequence of B12

hypovitaminosis, consisting of a severe, but treatable, neurologic disease if diagnosed early. It is detected through a classic triad, consisting of nystagmus (rapid eye movements), ataxia (loss of motor coordination) and confusional state. However, only 1/3 of the patients have this clinical triad clearly defined. Thus, caution should be taken while diagnosing this encephalopathy and extra attention to the presence of persistent memory, learning difficulties, and the classical triad (Fernandes et al, 2017).

The failure in the treatment of vitamin B12 replacement causes death in up to 20% of the cases, or progresses to Korsakoff syndrome (which happens in the chronic phase of this hypovitaminosis causing irreversible sequelae) linked with anterograde amnesia (inability of the brain to form new memories); short-term memory loss; compensatory confabulation (fake memories) and preservation of long-term memories and certain cognitive abilities. The late diagnosis of this disease leads to death (Fernandes et al, 2017; Kahl and Hillemacher, 2016).

Alcohol and Diabetes mellitus (DM) and metabolic syndrome (MS)

A European cohort study that included 60,000 participants pointed out that there is either a direct or indirect relationship between ethanol consumption and Diabetes Mellitus (DM). For example, the consumption can increase body mass index (BMI) - recognized as an essential cause for the occurrence of insulin resistance and type 2 DM (Fernandes et al, 2017).

In patients with DM, alcohol can act leading to two acute complications such as hypoglycemia, as a result of the inhibition of gluconeogenesis, which can lead to convulsion and death, if not identified and treated. The other acute complication that may occur is diabetic ketoacidosis, causing glycemic elevation and activation of the ketogenic pathway owing to the low insulin/glucagon ratio (Hermann et al, 2017). This fact is of great significance as a result of the high prevalence of alcohol use among young people. In a multicenter study with 29,000 patients, it was found that 10.8% of young patients with DM1 consumed alcohol, 19% of this number were individuals between 19 and 25 years of age. The total group had a lower rate of diabetic ketoacidosis and lower glycated hemoglobin. It was also observed that young people who consumed ethanol had a greater predisposition to tobacco use and worse glycemic control (Szücs et al, 2017).

The MS, defined by obesity, hypertension, dyslipidemia, and hyperglycemia, affects about 20 to 25% of the population. The association of alcohol with the MS is still controversial. The beneficial effect of alcohol can be explained by its action on lipid metabolism and blood coagulation since it is found a higher HDL and lower LDL-level as well as higher insulin sensitivity alcohol users in low doses compared to non-users. However, studies show an increased prevalence of MS in alcohol-dependent patients. This fact arises as a result of factors such as increased blood pressure, increased triglycerides/, increased abdominal circumference, and, therefore, an increased risk of DM2 (Hermann et al, 2017).

Alcohol is still a significant cause of chronic pancreatitis, a progressive inflammatory disease of the pancreas, associated with damage in its cellular function and its anatomical structure, leading to DM (Tilg, Moschen, and Szabo, 2016).

Alcohol and hepatopathy

Chronic alcohol use leads to a series of heterogeneous hepatic lesions, responsible for more than 2 million deaths annually (Rowe, 2017). Among these deaths, liver cirrhosis is responsible for 1 million deaths/year. Liver cancer, the most severe complication of

Alcoholic Hepatopathy (AH), causes about 800 thousand deaths. Among chronic diseases that reduce quality and life expectancy, the incidence of cirrhosis is only behind coronary heart disease, cerebrovascular disease, and chronic obstructive pulmonary disease (Zhang et al, 2017). Hepatitis has an occurrence of 10 to 35% in chronic drinkers, and it is responsible for 1/3 of morbidity and mortality, being a fundamental factor in the development of Alcoholic Hepatopathy (Addolorato et al, 2007). Also, AH is the second most frequent indication for liver transplant in Europe and North America, a total of about 20% to 30% of all liver transplants (Joshi et al, 2016; Marot et al, 2017; Chao, Waitzberg et al, 2016).

Multisystemic effects are frequent in patients with a history of chronic alcohol consumption and the presence of AH. These comorbidities include malnutrition, hypovitaminosis, loss of bone density, sarcopenia, hemolytic anemia, peripheral and central neurological abnormalities, and nephropathy (Joshi et al, 2016; Childers and Ahn, 2016).

The primary complications of this class of hepatopathy include hepatic steatosis; followed by acute alcoholic hepatitis and chronic alcoholic liver disease, causing cirrhosis and hepatic fibrosis (Chacko and Reinus, 2016). Also, hepatocellular carcinoma, which occurs in 5% to 15% of patients with alcoholic cirrhosis, is considered to be the most severe complication of AH (Pavlov et al, 2016).

Patients with AH are at the risk of developing fibrosis and liver cirrhosis, and this risk is higher when there is daily consumption of 20 to 40 g of ethanol for women and more than 80 g for men; in those whose Alanine and Aspartate Aminotransferase serum levels are elevated and present as comorbidities hepatitis C and obesity (Pavlov et al, 2016; Lasebikan and Ayinde, 2017).

Generally, patients with HA seek medical help when complications of cirrhosis appear (Pavlov et al, 2016). The vicious cycle of injury and repair that occurs in the liver after ingestion of alcohol results in collagen deposition among structures of the portal triad and central vein, cirrhosis of this etiology is characterized by small regenerative (micronodular) nodules (Lasebikan, Ola, and Ayinde, 2017).

Alcohol and the nervous system

Alcohol has a vital role in the pathogenesis of mental and behavioral disorders such as depression, attention deficit hyperactivity disorder (ADHD), anxiety disorder, irritation, obsessions and compulsions, phobia, difficulty in concentrating, schizophrenic psychosis, affective disorders, insomnia, antisocial behavior, and suicide. About the latter, it is related to severe intoxication

by this substance and cases of depression and bipolar disorders caused by alcohol consumption inducing suicide. Studies carried out by Lucchese *et al.* and Becker *et al.* (2017) showed that, in a group of alcohol and drug users, 37% of the individuals displayed a higher probability of developing mental disorders. The prevalence of pathologies, such as affective disorders in alcohol-dependent patients, is 23 percent. As for gender and age, the highest prevalence of mental disorders in alcohol and drug abusers is in women (mainly in mood and anxiety disorders) and patients under the age of 25 (Preuss *et al.*, 2017; Becker, Ehret and Kirsch, 2017; Lucchese *et al.*, 2017).

Ethanol is considered to be a depressant of the central nervous system by inhibiting glutaminergic (excitatory) pathways and stimulation of GABAergic (inhibitory) leading to relaxation modulated by the reward system.

Glutamate is a crucial excitatory neurotransmitter of the Central Nervous System (CNS), mediating 40% of glutaminergic synapses. Ethanol causes a reduction in NMDA Glutamate receptor activity and inhibition of the second messenger production (cyclic GMP) altering the synaptic function of this neurotransmitter and promotes CNS depression. In alcoholic patients, it occurs an up-regulation of NMDA receptors causing glutaminergic hyperactivity in the CNS during periods of abstinence that may lead to anxiety, delirium, and seizures (Preuss *et al.* 2017; Becker, Ehret and Kirsch, 2017).

Gamma-aminobutyric acid (GABA) is the important in the balance of the CNS depressant pathway. Alcohol increases the action of this neurotransmitter, as it mimics its action on α -type GABAergic receptors. At the moment GABA connects to the receptor, there is an opening of the chlorine and ion channels and with consequent neuronal hyperpolarization. During chronic use of ethanol, it is believed that down-regulation of α -GABAergic receptors is generated, generating alcohol tolerance and greater difficulty in the action of this neurotransmitter (Preuss *et al.*, 2017; Lucchese *et al.*, 2017).

The reward system belongs to the mesocorticolimbic circuit, where the production of pleasurable memories and stimuli occurs through the secretion of dopamine by receptors present therein (Lowenstein and Velazquez-Ulloa, 2018). The mechanism with which alcohol interferes in the reward system is derived from interaction in other receptor and neurotransmitter chains such as GABA (inhibitory), Glutamate (N-methyl-D-aspartate), Opioid (pleasure and analgesia) and Serotonin (mood-bound, 5-HT) (Orywal *et*

al., 2017). In addition, alcohol metabolites elevate the spontaneous activity of the ventral tegmental area, substantia nigra, and nucleus accumbens (mesocorticolimbic circuit) – brain regions rich in dopamine (Naassila, 2018).

It is believed that exposure to ethanol increases the expression of the tyrosine hydroxylase gene and its phosphorylation, which leads to greater dopamine synthesis since tyrosine is a precursor of this neurotransmitter. After chronic and continuous exposure to alcohol, it is possible to observe the degradation of the enzyme tyrosine hydroxylase with a reflex decrease, leading to a reduction in dopamine levels (Kawahata *et al.*, 2017).

Physiologically, the hypothalamus secretes corticotropin-releasing hormone (CRH) and vasopressin inducing the production of adrenocorticotrophic hormone (ACTH) by the pituitary gland. As a result, there will be a secretion of cortisol through the adrenal cortex. Cortisol exerts an effect on its receptors at the systemic level. In the receptors of the Hypothalamus-Hypophysis-Adrenal axis cortisol leads to negative feedback for synthesis and release of CRH and ACTH. In individuals with major depressive disorder and alcohol users, this negative feedback regulation does not occur. In this way, an increase in the activation of the Hypothalamic-Hypophysis-Adrenal axis leads to hypercortisolism. This phenomenon occurs while the individual is still addicted and consume alcohol to stop the negative effects of abstinence, and not for simple pleasure (Rachdaoui and Sarkar, 2017; Blaine *et al.*, 2016).

The use of ethanol in adolescence may result in cognitive and psychic deficits in adulthood. This occurs because neurotoxicity causes an inflammatory process destroying white and gray matter during brain maturation in youth. In fact, the use of alcohol in this age group can cause worsening in school performance, since two ethyl alcohol poisonings in this period are capable of permanently altering the synaptic plasticity in the hippocampus, a cerebral region fundamental to the learning process and memory formation.

Chronic exposure to ethanol causes long-lasting changes in synaptic transmission and neuronal excitability – also known to have long-term synaptic plasticity. These modifications are defined as an increase/decrease or potentiation/depression of synaptic activity. These phenomena of plasticity are currently the best neurobiological substratum of learning and memorization mechanisms. The chronic effect of alcohol on this basis of memory processes induces the formation of a pathological memory, which partly elucidates the motive for alcoholics to present relapses even after long

periods of abstinence or low exposure to the substance (Naassila, M. 2018).

IV. CONCLUSION

The consumption of alcoholic beverages has followed the history of humanity – deeply rooted in many cultures and part of countless people’s lifestyle nowadays. Alcoholism is considered a public health problem not only in Brazil but all over the world. The systemic effects of ethanol consumption are countless and can lead to death. Therefore, alcoholic patients need a multidisciplinary team of professionals who take an individual approach so that all the disorders caused by this pathology can be identified so that they can have better clinical management, better prognosis, and improvement in their lives.

REFERENCES

- [1] Addolorato, G., Leggio, L., Ferrulli, A., Cardone, S., Vonghia, L., Mirijello, A. and Haber, P. S. 2007. Effectiveness and safety of baclofen for maintenance of alcohol abstinence in alcohol-dependent patients with liver cirrhosis: randomised, double-blind controlled study. *The Lancet*, 370(9603), 1915-1922.
- [2] Barbosa, C. D. and Ferreira, C. C. D. 2017. O papel da nutrição no processo reabilitatório de dependentes de álcool. *Cadernos UniFOA*, 6(1 (Esp.)), 89-101.
- [3] Barve, S., Chen, S. Y., Kirpich, I., Watson, W. H. and McClain, C. 2017. Development, prevention, and treatment of alcohol-induced organ injury: The role of nutrition. *Alcohol research: current reviews*, 38(2), 289.
- [4] Becker, A., Ehret, A. M., and Kirsch, P. 2017. From the neurobiological basis of comorbid alcohol dependence and depression to psychological treatment strategies: study protocol of a randomized controlled trial. *BMC psychiatry*, 17(1), 153.
- [5] Blaine, S. K., Milivojevic, V., Fox, H. and Sinha, R. 2016. Alcohol Effects on Stress Pathways: Impact on Craving and Relapse Risk. *Canadian journal of psychiatry. Revue canadienne de psychiatrie*, 61(3), 145-53.
- [6] Boye, A., Zou, Y. H., and Yang, Y. 2016. Metabolic derivatives of alcohol and the molecular culprits of fibro-hepatocarcinogenesis: Allies or enemies?. *World journal of gastroenterology*, 22(1), 50. DOI: 10.3748/wjg.v22.i1.50
- [7] Chacko, K. R. and Reinus, J. 2016. Spectrum of alcoholic liver disease. *Clinics in liver disease*, 20(3), 419-427. DOI: <https://doi.org/10.1016/j.cld.2016.02.002>.
- [8] Chang, J. S., Hsiao, J. R. and Chen, C. H. 2017. ALDH2 polymorphism and alcohol-related cancers in Asians: a public health perspective. *Journal of biomedical science*, 24(1), 19. Doi : 10.1186/s12929-017-0327-y
- [9] Chao, A., Waitzberg, D., de Jesus, R. P., Bueno, A. A., Kha, V., Allen, K. and Medici, V. 2016. Malnutrition and nutritional support in alcoholic liver Disease: A review. *Current gastroenterology reports*, 18(12), 65. DOI 10.1007/s11894-016-0539-4
- [10] Chi, Y. C., Lee, S. L., Lai, C. L., Lee, Y. P., Lee, S. P., Chiang, C. P., and Yin, S. J. 2016. Ethanol oxidation and the inhibition by drugs in human liver, stomach and small intestine: Quantitative assessment with numerical organ modeling of alcohol dehydrogenase isozymes. *Chemico-biological interactions*, 258, 134-141. <http://doi.org/10.1016/j.cbi.2016.08.014>.
- [11] Childers, R. E. and Ahn, J. 2016. Diagnosis of alcoholic liver disease: key foundations and new developments. *Clinics in liver disease*, 20(3), 457-471. DOI: <https://doi.org/10.1016/j.cld.2016.02.005>.
- [12] Dinis-Oliveira, R.J. 2016. Oxidative and non-oxidative metabolomics of ethanol. *Current drug metabolism*, 17(4), 327-335.
- [13] Fernandes, L. M. P., Bezerra, F. R., Monteiro, M. C., Silva, M. L., de Oliveira, F. R., Lima, R. R. and Maia, C. S. F. 2017. Thiamine deficiency, oxidative metabolic pathways and ethanol-induced neurotoxicity: how poor nutrition contributes to the alcoholic syndrome, as Marchiafava–Bignami disease. *European journal of clinical nutrition*, 71(5), 580.
- [14] Hermann, J. M., Meusers, M., Bachran, R., Kuhnle-Krahl, U., Jorch, N., Hofer, S. E., and DPV initiative. 2017. Self-reported regular alcohol consumption in adolescents and emerging adults with type 1 diabetes: A neglected risk factor for diabetic ketoacidosis? Multicenter analysis of 29 630 patients from the DPV registry. *Pediatric diabetes*, 18(8), 817-823. Doi: 10.1111/pedi.12496
- [15] Joshi, K., Kohli, A., Manch, R. and Gish, R. 2016. Alcoholic liver disease: high risk or low risk for developing hepatocellular carcinoma?. *Clinics in liver disease*, 20(3), 563-580.
- [16] Kahl, K. G., and Hillemacher, T. 2016. The metabolic syndrome in patients with alcohol dependency: Current research and clinical implications. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 70, 49-56. Doi:10.1016/j.pnpbp.2016.05.001
- [17] Kawahata, I., Evelyn, G. R., Huinan, X., Ohtaku, S., Tomioka, Y., and Yamakuni, T. 2017. Tyrosine hydroxylase gene expression is facilitated by alcohol followed by the degradation of the protein by ubiquitin proteasome system. *Neuro endocrinology letters*, 38(1), 43-49.
- [18] Lasebikan, V., Ola, B. A. and Ayinde, O. O. 2017. Effectiveness of alcohol, smoking, and substance involvement screening test-linked brief intervention on harmful and hazardous alcohol use in Nigerian Semirural Communities: A Non-Randomized Intervention Study. *Frontiers in psychiatry*, 8, 50. <https://doi.org/10.3389/fpsy.2017.00050>.
- [19] Lowenstein, E. G., and Velazquez-Ulloa, N. A. 2018. A Fly's Eye View of Natural and Drug Reward. *Frontiers in physiology*, 9, 407. doi:10.3389/fphys.2018.00407
- [20] Lucchese, R., Silva, P. C. D., Denardi, T. C., de Felipe, R. L., Vera, I., de Castro, P. A. and Fernandes, I. L. 2017.

- TRANSTORNO MENTAL COMUM ENTRE INDIVÍDUOS QUE ABUSAM DE ÁLCOOL E DROGAS: ESTUDO TRANSVERSAL. *Texto&ContextoEnfermagem*, 26(1), 1-7.
- [21] Lucchese, R., Silva, P. C. D., Denardi, T. C., de Felipe, R. L., Vera, I., de Castro, P. A. and Fernandes, I. L. 2017. Transtorno mental comum entre indivíduos que abusam de álcool e drogas: Estudo transversal. *Texto & Contexto Enfermagem*, 26(1), 1-7.
- [22] Marot, A., Henrion, J., Knebel, J. F., Moreno, C. and Deltenre, P. 2017. Alcoholic liver disease confers a worse prognosis than HCV infection and non-alcoholic fatty liver disease among patients with cirrhosis: An observational study. *PLoS one*, 12(10), e0186715. <https://doi.org/10.1371/journal.pone.0186715>
- [23] Matejčić, M., Gunter, M. J., and Ferrari, P. 2017. Alcohol metabolism and esophageal cancer: a systematic review of the evidence. *Carcinogenesis*, 38(9), 859-872.
- [24] Miquel, L., Gual, A., Vela, E., Lligoña, A., Bustins, M., Colom, J. and Rehm, J. 2016. Alcohol consumption and inpatient health service utilization in a cohort of patients with alcohol dependence after 20 years of follow-up. *Alcohol and Alcoholism*, 52(2), 227-233. <https://doi.org/10.1093/alcal/agw075>
- [25] Naassila, M. 2018. Bases neurobiologiques de l'addiction à l'alcool. *La Presse Médicale*.
- [26] Navarro, A. C. and Navarro, F. N. 2013. Revista Brasileira de Obesidade, Nutrição e Emagrecimento. ISSN 1981-9919
- [27] Nene, A., Chen, C. H., Disatnik, M. H., Cruz, L. and Mochly-Rosen, D. 2017. Aldehyde dehydrogenase 2 activation and coevolution of its εPKC-mediated phosphorylation sites. *Journal of biomedical science*, 24(1), 3. doi : 10.1186/s12929-016-0312-x.
- [28] Orywal, K., Jelski, W., Werel, T. and Szmítkowski, M. 2017. The activity of class I, II, III and IV alcohol dehydrogenase isoenzymes and aldehyde dehydrogenase in the sera of bladder cancer patients. *Acta Biochimica Polonica*, 64(1). http://dx.doi.org/10.18388/abp.2016_1289.
- [29] Pavlov, C. S., Casazza, G., Nikolova, D., Tsochatzis, E. and Gluud, C. 2016. Systematic review with meta-analysis: diagnostic accuracy of transient elastography for staging of fibrosis in people with alcoholic liver disease. *Alimentary pharmacology & therapeutics*, 43(5), 575-585. doi: 10.1111/apt.13524
- [30] Pavlov, C. S., Casazza, G., Semenistaia, M., Nikolova, D., Tsochatzis, E., Liusina, E. and Gluud, C. 2016. Ultrasonography for diagnosis of alcoholic cirrhosis in people with alcoholic liver disease. *The Cochrane Library*. Cochrane Database of Systematic Reviews 2016, Issue 3. Art. No.: CD011602. DOI: 10.1002/14651858.CD011602.pub2.
- [31] Preuss, U. W., Gouzoulis-Mayfrank, E., Havemann-Reinecke, U., Schäfer, I., Beutel, M., Hoch, E. and Mann, K. F. 2017. Psychiatric comorbidity in alcohol use disorders: results from the German S3 guidelines. *European archives of psychiatry and clinical neuroscience*, 1-11. doi: 10.1007/s00406-017-0801-2
- [32] Preuss, U. W., Gouzoulis-Mayfrank, E., Havemann-Reinecke, U., Schäfer, I., Beutel, M., Hoch, E. and Mann, K. F. 2017. Psychiatric comorbidity in alcohol use disorders: results from the German S3 guidelines. *European archives of psychiatry and clinical neuroscience*, 1-11. Doi: 10.1007 / s00406-017-0801-2.
- [33] Rachdaoui, N. and Sarkar, D.K. 2017. Fisiopatologia dos Efeitos do Abuso de Álcool no Sistema Endócrino. *Pesquisasobreálcool: revisões atuais*, 38 (2), 255-276.
- [34] Robinson, S. M., and Adinoff, B. 2016. The classification of substance use disorders: historical, contextual, and conceptual considerations. *Behavioral Sciences*, 6(3), 18. *Behav. Sci.* 2016, 6, 18; doi: 10.3390/bs6030018.
- [35] Rowe, I. A. 2017. Lessons from epidemiology: The burden of liver disease. *Digestive Diseases*, 35(4), 304-309. OI: 10.1159/000456580
- [36] Sluik, D., Jankovic, N., Hughes, M., O'doherty, M. G., Schöttker, B., Drygas, W. and Bamia, C. 2017. Alcoholic beverage preference and diabetes incidence across Europe: the Consortium on Health and Ageing Network of Cohorts in Europe and the United States (CHANCES) project. *European journal of clinical nutrition*, 71(5), 659.
- [37] Szűcs, Á., Marjai, T., Szentesi, A., Farkas, N., Párniczky, A., Nagy, G. and Németh, B. C. 2017. Chronic pancreatitis: Multicentre prospective data collection and analysis by the Hungarian Pancreatic Study Group. *PLoS one*, 12(2), e0171420. <http://dx.doi.org/10.1371/journal.pone.0171420>
- [38] Testino, G., Leone, S., Ansaldi, F. and Borro, P. 2016. Alcohol and liver transplantation: the 6-month abstinence rule is not a dogma. *Transplant International*, 29(8), 953-954. <https://doi.org/10.1111/tri.12790>
- [39] Tilg, H., Moschen, A. R., and Szabo, G. 2016. Interleukin-1 and inflammasomes in alcoholic liver disease/acute alcoholic hepatitis and nonalcoholic fatty liver disease/nonalcoholic steatohepatitis. *Hepatology*, 64(3), 955-965. DOI 10.1002/hep.28456
- [40] Wall, T. L., Luczak, S. E., and Hiller-Sturmhöfel, S. 2016. Biology, genetics, and environment: underlying factors influencing alcohol metabolism. *Alcohol research: current reviews*, 38(1), 59.
- [41] Zhang, X., Wang, H., Yin, P., Fan, H., Sun, L., and Liu, Y. 2017. Flaxseed oil ameliorates alcoholic liver disease via anti-inflammation and modulating gut microbiota in mice. *Lipids in health and disease*, 16(1), 44. DOI 10.1186/s12944-017-0431-8

The Naturalization of Violence from State Apparatus in the Process of Lapa Carioca Revitalization: Legal Measures, Ennoblement and Segregation

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Abstract— Cities are constituted by peculiarities and heterogeneous areas: a central region, peripheral regions, waterfront and favelas. Squeezed between the sea and the mountain, the city of Rio de Janeiro had its architectural project marked by the occupation of hills and the expansion in valleys and marshes, so several processes of grounding at the expense of demolitions were necessary. Due to the rather rugged geography, the city has constantly evidenced and still evidences the need for reforms. Following this line of reasoning, we aim at focusing on an urban reform: the revitalization of Lapa neighborhood. In order to do so, we perform a bibliographical research encompassing theoretical lines of approach that corroborate our premises. Our dive into the literature on the revitalization process revealed that the concept is dynamic and admits several interpretations according to social, economic, political and geographical aspects. However, it is necessary the understanding about revitalization as a process that, does not condemn the existing forms to extinction, but aims at recovering them, giving them a new aesthetic appearance and new modalities of use. We can also state that the justifications for revitalization are based on the idea of chaos and disorder, but the aspect that moved the revitalization of Lapa are related to business interests linked to the economic sector, which resulted in a deep social transformation with the segregation of actors by gentrification, a sprawl of the commerce sectors as well as the leisure sectors and the controlled selectivity of people due to the consumption capacity.

Keywords— Gentrification, Legal Measure, Memory, Urban reform, Violence.

I. INTRODUCTION

Due to the built space, cities establish conditions and types of social relationships, producing and reproducing material and cultural aspects and are therefore determinant factors of the life of the citizen, making a process of adaptation, both physical and mental, necessary for their survival. It is concerning the web of relations, at various levels, that the difficulties are increased for the people and also in the management of the minimum conditions of ideal functioning. That is to say, cities, in the condition of living organisms, are subject to several obstacles, from natural phenomena until the consequences of the alienated intervention of the human being. However, cities owe their creation to the process of accumulation and exchange of goods, as well as the movement of people. After being created they are exposed to distinct processes: development, stagnation, abandonment, illness and, in some cases, disappearance.

The complexity of the cities represents a big challenge for its managers in terms of planning and implementing actions due to the requirements that demand new answers. For this reason, reform plans must be based on both the architectural scenarios and the human groups that enable a region, since it is because of the conditions of the possibility of remaining in the ennobled region; or lack of the same conditions for the people who are removed. We must certainly consider the complexity of cities on different angles and, according to Moroni and Cozzolino (2019), the heterogeneity, despite a predominant factor, is not the only aspect, since there are in the multiple cities chains of actions that intertwine, producing webs of contour, especially if we focus on the subjective conditions that are articulated, being directly affected by the nuances of the architectural structures. That is, human actions are a special determinant in the configuration and complexity of cities. They are the interactions among people, buildings, monuments,

squares, vehicle routes, trees, urban animals, among other aspects that make cities a living space, but above all a complex and dynamic space.

Facing this dynamism cities have had managers to care for their living conditions through the maintenance and preservation of regions, which, for many reasons, deteriorate or are neglected. The management policy was mainly based on the strengthening of the cities due to the possible invasions and looting. This form of understanding changes radically with capitalism, in which city management followed the economic criterion, whose peak, in the twentieth century, is with the business force and its interests in the pursuit of urban reforms. This type of business determination in cities has as main characteristic, according to Harvey (1996, p. 52):

[...] the notion of a "public-private partnership" in which a traditional local boosterism is integrated with the use of local governmental powers to try and attract external sources of funding, new direct investments, or new employment sources.

This panorama of the cities' journey, in general, can also be brought to the reality of the city of Rio de Janeiro, which, from its origin, has faced - and still faces - serious problems of urbanization, due, on the one hand, to its configuration and, on the other hand, to the many problems related to social inequality that became more pronounced after the Abolition of Slavery, along with the process of displacement of people fighting for survival.

The critical situation of this metropolis, due to the aggravating factors mentioned above, had such a repercussion to the point that the city has been the scene of numerous urban reforms historically motivated by: a) modernization; b) centralization of culture; c) promotion of tourism; and d) events with global repercussions. In order to transform the city into a metropolis inspired by European models, Mayor Pereira Passos, at the beginning of the 20th century, was responsible for carrying out urban reforms so that the city would resemble the French capital, not by chance, since the mayor studied in Paris, coincidentally at the same time when Baron Haussmann became worldwide known in implementing this reform project.

Aside from the Pereira Passos Reform and some modifications such as the Aterro do Flamengo, in which economic interests were not the flagship, the others, under different allegations, aimed at ennoblement of certain regions, due to the expectation of real estate speculation. In this sense, we cast a glance towards a region of the city of Rio de Janeiro, which presents singularities in its endless process of revitalization: the Lapa neighborhood.

Lapa became world-renowned as a symbol of the city of Rio de Janeiro by following the shape of the French capital at the end of the 19th century, being the central nucleus of the so-called Paris of the Tropics, which, according to Lessa, was seen (2001, p. 13) "as a country business card and a Brazilianness certificate, [it] was the only place that combined tropical nature with urban modernity". However, the allusion to modernity must be understood in its many aspects: progress, quality of life, catastrophes, misery, overpopulation through the promise of a comfortable life, violence by the competition of spaces and means of survival and, finally, all sorts of self-problems of living in large urban conglomerates.

Considering the cities under the aspect of their marked heterogeneity we have people installed in safe and comfortable housing as well as adult people in situation of social abandonment that live in the streets, adrift. In this way, we can state that cities are producers of chaotic situations, especially in the face of the provision of selective services for some segments of the population. In addition, after World War II, the great metropolises:

[...] faced a process of decadence characterized by the precariousness of housing conditions in central areas, the escapism of urban elites and the retreat of public space, emptied of its political dimension. At the same time, the popularization of consumer goods, especially communication technologies, linked to private leisure, seems to have led people to go out less and adopt other forms of social interaction (GOIS, 2014, p. 223).

The changes in the *modus vivendi* referred to above are due, mainly, to the power of consumption. This shows the most direct reflexes of social inequality: people with consumption power who produce garbage and people who live consuming this garbage. This is the context that seals the process of exclusion and social segregation. That is to say, by analyzing this question with a certain tone of irony, we can affirm that the link that maintains the union between those who are perfectly included in the cities with those who are excluded, is certainly the garbage, at least in the current world. In the first category, we find the people who, due to the economic condition, are integrated into the system by consumption; while the second is the category of people who, curiously, survive from the material discarded by consumption, of what is left over and is no longer useful.

This is the scenario that has gained considerable space in cities since the late nineteenth century in Brazil, because as Lessa (2000, p.12) states, "the Brazilian city of the nineteenth century was altered by substantial parameters by the first industrial revolution. Although it

was not the center of industrialization, it knew the steam engine, the iron ship, the railroad and the steel undercut". The advent of these improvements is in the midst of the modernization of the city of Rio de Janeiro with the attempt to approach the European way of life, obliterating the roots that reaffirmed and affirm social inequality. This complex transformation of the urban scenario resulted in the need for people for the workforce, and thus the large-scale incorporation of free people (formerly living in slavery) and poor people for the execution of the so called heavy and risky services.

The multiplication of poor and free people in Rio de Janeiro- at the time the capital of the country (a center where cultural, economic and political life used to pulse, a mandatory reference for all national territory), caused many disorders, mainly because these people and their habits were interpreted by the elite as a way of affronting them. It is worth, in this respect, to make reference to the thought of Mbembe (2017, p. 131) for whom:

The town belonging to the colonized people . . . is a place of ill fame, peopled by men of evil repute. They are born there, it matters little where or how; they die there, it matters not where, nor how. It is a world without spaciousness; men live there on top of each other. The native town is a hungry town, starved of bread, of meat, of shoes, of coal, of light. The native town is a crouching village, a town on its knees. In this case, sovereignty means the capacity to define who matters and who does not, who is disposable and who is not.

We can reflect on the above retraction and consider the dynamics of the city of Rio de Janeiro in its different temporalities, each with its repressive mechanisms of control, vigilance and also extermination. In this way, the city, instead of being considered a totality, represents several niches inaccessible and that differ from each other, configuring a truly parted city as Ventura (1994) points out.

In order to maintain conditions that contribute to social inequality, in the case of Rio de Janeiro, social control apparatuses enter the scene, whose actions culminated in its first major reform: Rodrigues Alves and Pereira Passos reforms, both carried out under the justification of contamination controlling, which are widespread as a kind of danger to the population.

Nearly fifty years later, a region of the city very close to the revitalized area in the early twentieth century showed signs of decay and degradation. It should be noted that Lapa, for a long time, was a link between the powers of the Republic: the maximum seats of the judicial and legislative branches were located in

downtown and the maximum seat of the executive power was located in Catete neighborhood.

Perhaps this evidence justifies why Lapa was preserved, since the transference of the federal capital to Brasília accentuated the situation of decline and abandonment. That is to say: when projecting the luminosity in a certain region the government runs the risk of leaving so many in the penumbras or even in the darkness. The shadows that fell in Lapa produced indelible damages used effectively by the economic power in alliance with the public power in the real estate speculation. The several steps of the gentrification process are allied to this factor.

Observing the historical process of occupation of Lapa Carioca from the end of the nineteenth century until the middle of the twentieth century, we can see that, at first, the region was composed of professionals from the popular classes of butchers, glaziers, barbers and small businesses - that is, they used to work in the same place they lived, as explained by Araújo (2009, p.29). At the same time, the focus of night life in the neighborhood was bohemia, as well as it also housed rooms, inns, bars and cabarets. It was a region frequented by great artists, painters who lived in Santa Tereza neighborhood, sambistas and erudite people who used to watch to concerts from Cecília Meireles Room. This bohemian atmosphere saw the great decline in the early 1950s from a repressive policy against prostitution, which perhaps contributed most to the emptying of the neighborhood by the association between entertainment and prostitution. Then the Lapa Carioca was left to its own fate, being the region known as a place of violent acts.

Finally, we intend to identify, in the process of revitalization, the vectors of economic nature that were evidenced by the ennoblement, beautification, social segregation and selectivity of users of the region and its multiple services, sedimented by gentrification, as pointed out by Gervehr and Berti (2017). We also want to highlight that the business-economic question is not unconnected to the formulation of the strategic revitalization plans.

To some extent, we are pointing out that the intentions as well as the planning of an urban reform process have an economic objective that is to produce an image of the city that is negotiable, because in these circumstances, cities are evidently a product to be sold. Therefore, some precautions should be taken in the sense of raising values, especially real estate values.

The obvious consequence of this undertaking can be considered in relation to science, by some people that will be forced to leave their homes and, by extension,

also leave the neighborhood that they live because of their economic conditions. We notice, then, a nuance of the revitalization process that must be considered, since the public power does not seem to attach importance to the fact that these people have built their lives there and will be forced to chart new directions to survive in precarious and distant resettlements from urban centers or noble neighborhoods where they usually work.

II. HISTORICAL FRAMES OF LAPA CARIOCA

Concerning the geography of Rio de Janeiro, Lapa was constituted, according to Xavier et al. (2012, page 7), "for wetlands, situated between hills, ponds and swamps". Lapa was a quiet region until the arrival of the Royal Family to Brazil, when it was populated by the elite of Rio de Janeiro who were eager for prominence and recognition because of the proximity of the Court. As a result of the change in this scenario, the neighborhood had in the nineteenth and early twentieth century its apogee with the opening of houses for fun, casinos, taverns, inns and brothels. In this way, a new scenario was created due to the presence of commercial establishments, most associated to bohemia; Lapa was even recognized as a meeting place for musicians, writers, painters and intellectuals to meet.

From a bohemian space, Lapa became feared and avoidable due to marginalization, becoming a ruined neighborhood: abandoned houses, proliferation of tenements, absence of public goods and services, among others. These historical nuances are important to understand Lapa in the context of an irregular morphology, either from an occupational point of view; either from the physical point of view that required:

interventions at different times in its history, among which we highlight: the grounding of the Lagoa do Boqueirão in the 18th century, with the dismantling of Morro das Mangueiras, the opening of the axis formed by Avenida Mem de Sá and Salvador de Sá, Morro do Senado, during the Pereira Passos administration (1902-1906); the destruction of the Morro de Santo Antônio, with the opening of great avenues, such as Avenida Chile and the República do Paraguai avenue, between the 1950s and 1970s; the renovation project of Largo da Lapa, in the 1990s (XAVIER, et al. 2012, p. 7).

As we can see, the Freguesia da Glória, currently known as Lapa, Glória and Catete, has proved to be a very unsuitable terrain for housing, requiring several interventions in its geographic configuration, mainly grounding of ponds and marshes and landslides. The interventions aimed mainly at occupying the spaces reformed by people of high social class. Evidently the people who once inhabited these places were removed to

the periphery under various allegations, mainly because they are considered, by the public power, agents that caused disorder and chaos.

In this regard, it is important to note that the Lapa neighborhood not only had irregular spatial dynamics, but also historically was marked by a diversity of buildings and social actors who, once removed, but kept alive, insist on reappear, being thus a strong resistance pole. These heterogeneous dynamics are aligned, from the architectural point of view, with the concept of roughness understood as the harmonization of styles present in spaces of different epochs (SANTOS, 2014). In addition to this architectural plurality, a plurality of social actors is also observed, some of whom are considered to cause disorder and chaos, especially those left over from the labor and consumer market, as well as those considered undesirable due to different stigmas.

The lack of conservation of the architectural patrimony and the absence of the public power, in a way, contribute to the degradation of the region and the appearance of violent actions such as robberies, drug trafficking, among others. The situation reached an extreme that justified the intervention of the repressive apparatuses of the State, at first, and the continuity of practices of control and vigilance from the process of restoration or revitalization of the region, in a second moment.

In an attempt to change the neighborhood's degradation and decay scenario, a revitalization process was undertaken, based on various nuances such as the recovery and revaluation of the region, for the following purposes: 1) to promote the integration of the citizen into the city through sophistication and comfort, at the expense of a rigid process of security, discipline, and social control. Thus, an ordering of urban space is produced, through differentiated strategies; 2) to create and propagate an image of civility and well-being for people, promising them to return to the feared and emptied spaces before the threat of violence; 3) to legitimize the elitist and exclusionary order, in a way, reusing the principles of the Pereira Passos Reform, which prevailed through social cleansing with order and embellishment.

Regarding the revitalization of Lapa, this process counted on the action of gentrification, in a pact of the Economic Power with the Public Power. Gentrification, according to Smith (2007), is a powerful mechanism of social segregation that corroborated so that the people removed could never return to live where they were born and grew up. It is an intimidating process, sometimes

quite silent, but carried out continuously with agents always vigilant, for its maintenance, since there has been urban reform and modified the human and architectural setting, but with selectivity of people. According to Ribeiro (2018, p. 1335), gentrification is:

a plexus of diverse phenomena that go from the changes of frequenters in a certain locality to the removal of residents for interventions of urban beautification, without more reflections on the individual senses of these references and their adequacy to the phatic reality that is intended to subsume them. More than a concept, the word "gentrification" expresses a social, economic and spatial process that goes far beyond the exit of residents caused by the forces of capital, or the reform of physical spaces in the city.

The preponderant factor to implement gentrification was the diffusion of the stigma about the fact that the social condition is an aggravating factor for the violence and thus the poverty was frontally marginalized and incriminated, being the poor objects of punishment (WACQUANT, 2007). In the wake of action of social apparatuses, marginalized populations were the target of three major operations to justify the selectivity of people, segregation and withdrawal from circulation, a practice that resonates with state projects of other times.

The first operation, carried out in a hidden way, consists in disseminating an ideological discourse of disqualification of some people that circulate in the region, such as adults in situations of social abandonment, very small peddlers, as well as those who have no purchasing power to settle to the new conditions of the neighborhood resulting from the process of gentrification. These social groups are demonized by their close association with problems of disorder, spread of disease, increase of crime, trafficking of narcotic substances, to justify the action of state apparatuses by the segregation of these people, besides those that were removed during the works of transformation of the neighborhood. These social surplus are considered a great impure mass, at the same time undesirable because of the reasons previously mentioned, since this mass is interpreted as a source of threatening, however, extremely necessary for the fact of representing a low cost labor to perform the services of commercial houses and luxurious houses, without their owners dispensing great amounts of money. Paradoxically, this contingent of people must be segregated but not eliminated so as not to jeopardize the provision of services because they are needy people who readily accept any offer without further negotiations. It is the only possibility of these people to circulate in the noble areas of the city.

The second stage, intrinsically linked to the first, consists of the enhancement of the regulatory mechanisms of these people, dissociating themselves from the productive processes in specialized services. Once stigmatized as disqualified people they are recognized only for a few activities that usually require a great physical effort, which does not require in-depth specialization for the elaboration and execution of certain tasks, such as diarists, waiters, furniture repairers, hydraulic firemen, doormen and security guards. These people, due to a low professional qualification, when carrying out these activities, and undergoing a process of personal and professional undermining, see their self-esteem shaken, and obviously, in these circumstances, they confirm the condition of inferiority imputed to them.

The third stage, which constitutes a closing scene, radicalizes the two precedents when the gap separating the dominant elite from the segregated class really becomes effective, to the point that both social categories do not recognize each other. There is then a kind of estrangement, in the sense of which the bonds of solidarity are completely broken in such a way that certain regions of large cities, such as Lapa, even after being revitalized, present in their daily life a scenario quite heterogeneous and equally deformed, in broad daylight: adult people in a situation of social abandonment sleeping under marquees, church chapels, building stairs and well-dressed people who circulate to get to their jobs, students to their schools, tourists, people who expect others to enjoy the sumptuous cafes and bookstores.

It is important to highlight that the first category of people is the great challenge of the state authorities who intend to give the region an air of purity by continually removing them for shelters, usually on Fridays every week. But these people repeatedly leave the shelters and return, once again, to be considered not as human beings, but as specimens of social detritus that smell badly and should be discarded or immediately segregated. They are no longer considered men or women, although they once were, but dehumanized specters that still move. However, people who go to work, schools or shopping experience two paradoxical sensations in general: they are indifferent to the scenario before them or they feel uncomfortable to think that the presence and existence of these still almost people disrupt, from the aesthetic point of view, the beauty of their days.

III. THE CONSTRUCTION OF METHODOLOGICAL REFERRALS

The circumscribed methodological contribution for the analysis that we are proposing is based on closely related procedures. Firstly, the selected questions point us guidelines to be followed, such as tracking traces of maps, photographs, master plans, news. Therefore, our focus in this material concerns characterizing the different configurations of the neighborhood, in a cover that refers to different epochs of the city's history. This is our starting point in the search for aspects about a *modus vivendi* regarding the geographic, social and economic conditions of the neighborhood.

This typology of traces, once directly articulated in its different nuances, makes us understand that the process of revitalization of an urban region, when it is carried out, brings in its core issues of a different nature, not always being explicit by the executors their real interests. This experience of proximity to the material, conditioned, above all, by the routing extracted from the chosen theoretical corpus, enables us to carry out a scientific path with a view to delineating certain obscurities proper to the process of revitalization, mainly due to gentrification. In this way, we are considering the architectural changes and also the numerous voices silenced, that have been eliminated, becoming, metaphorically, types of hauntings that, at any movement, can erupt and take out the sleep of people with considerable purchasing power.

Thirdly, the evidence (traces, documents, maps, photographs, graffiti of social complaint), which we examine in our approach, compose a writing that constitutes a memory, which problematizes both the officially constituted memory, and the forms that have been or are still hindered of expression. However, we are aware that the city as a living organism requires a careful look, but this circumstance is not in itself indicative of a process of revitalization, not considering the conjuncture of actors of a given region: its architectural heritage, the legacies of its history, the people who inhabit it, as well as those who pass through it. That is to say, the ethical guidance that we are led to adopt presupposes an equal appreciation of the physical and human agents of the region, so that buildings and monuments are as important as people regardless of their social conditions.

In addition to the above, we point out that the set of procedures selected for our reflection consists in establishing parameters of understanding that elucidate the complexity of a revitalization process, especially considering the interpretative character from the argument extracted from the theoretical support scheme. However,

it is a path to be opened and built gradually, reason why we will not adopt the generalizing perspective, that is, our considerations represent one of the multiple possibilities of meaning.

From this perspective, the context that supports the approach to the question that guides our reflection can be presented in two aspects.

First of all, we will adopt the position of constructing arguments to serve as a tool in the process of analyzing organized material. Thus, we conform a type of narrative that concerns the reforms occurred in Lapa, but in terms of including the variations of the architectural landscape, without relegating to the background the dynamics of social relations, especially regarding the people who had their lives dramatically changed. These people, even silenced, left traces that signal their passages and some of them have risen into real resistance movements, denoting not only the reality that result from revitalization but also the subjective damage caused.

Secondly, we will focus on the analysis of spatial roughness, investigating the possible coexistence of what go through temporalities, in a kind of coexistence harmonized by the imposition of state apparatus. Also, we are considering changes that affect the life of the city, even if they are restricted to a region such as the region of Lapa. In this way, we want the revitalization of Lapa to be capillarized by practically the entire city of Rio de Janeiro, mainly due to the displacement and concentration of nightlife for a social segment with a high power of consumption.

Finally, the analysis we intend to do considers the productions of the urban reform, in terms of importance, both to reflect on the ennobled architectural scene, as well as the measures of segregation that are maintained by the policies of surveillance and social control. For this reason, we also consider that the new buildings portray hidden and pulsating ruins. It is of extreme importance that we do not relegate this aspect in our analysis.

This is the scope of our reflection: the people who made up a pre-retirement scenario, as well as the buildings that have been demolished represent, at the present time, ruins and voices that have the same value of the current people that circulate in the area and current monumentalities. It is by these very small tracts, sometimes hidden or concealed, that we ventured to think of a nuance of the revitalization process, that is the segregation, which is not very important for those who are in a position to make the decisions in projects of this nature.

As a warning to our reflective referral we want to signal that revitalization is a very contradictory process: it restores, ennobles, but also promotes the disappearance of streets, buildings and other references, as well as it mutes the voice of many people forever.

IV. THE REVITALIZATION OF LAPA IN FOUR MOMENTS

Before approaching the revitalization of Lapa, it is important to characterize the nature of the strategic plan that is based on four sequential and concatenated stages; both in terms of objectives and in terms of the expected results from an architectural and human point of view.

Firstly, a determinant for the elaboration of a plan of revitalization is the recognition, by the public power, of the unintentional or purposeful abandonment of a given region that knows increasing levels of degradation and decay. That is, public power does not always intervene when the first signs of deterioration of an urban space are evident. It is necessary, therefore, the presence of serious degradation conditions so that a diagnosis is established in order to justify the action of the State.

Regarding Lapa, the diagnosis was based on two premises: the idea of disorder related to the presence of people belonging to different social strata and the violence that frightened consumers and practically forced the merchants to close their homes. The diagnostic process considers the occupation of the region, day and night passers-by, urban and social issues, but above all, the condition of housing and polo of cultural and tourist activities, as well as the preservation of historical and architectural patrimony. The dissemination of the diagnosis of urban chaos meets a very receptive and hopeful population in relation to social well-being and the production of solutions to the issue of fear and insecurity.

The second stage considers the unique and historical particularities of the region, which, as already mentioned, are currently based on terraced marshes and ponds, demolition of hills and drainage of water. Perhaps it was this historical past that was responsible for the preservation of the Arcos da Lapa and its diffusion with the iconic symbol of the region. In a retrospective way, the great investment of the public power is justified in several urban reforms initiated in century XVIII, according to Xavier et al. (2012) by grounding of Lagoa do Boqueirão and dismantling of Morro das Mangueiras. In this sense, the region of Lapa is constituted by a very rugged and misshapen geography, very different from the current landscape.

The third pillar of establishment of a strategic plan is to list arguments that justify its purpose,

demonstrating the imperative need to achieve. The major motivator for such a project hardly comes to the fore: it is the economic interest directly related to real estate speculation gradually produced by gentrification, that is, "the origin of the pattern of social segregation that occurs in cities of any economy today is the consequence of economic transformations which happened in the past" (FURTADO, 2014, p. 344). It is understood, therefore, that gentrification is a process that is related, to a certain extent, both to social inequalities and to the mobility of people, to the point of determining new patterns and living standards in terms of consumption and transformations produced in space and its use. In a sense, gentrification, slowly but intensely, produces a drastic change in the *modus vivendi* of certain social actors, by expelling those who are considered undesirable and adrift.

As a general rule, this process works from three unbeatable arguments about the deterioration of a region, such as Lapa: 1) the deterioration of the life quality of its users in terms of security, 2) the scouring of people in the public space of coexistence with restriction of the horizons of relationship and, 3) loss of traditional values by the expression of violence. These arguments are presented by the public authority and agreed by the population as a solution to the state of chaos and disorder identified in the diagnosis, according to which two solutions are proposed: 1) renovation of certain areas with predicted destruction for creation and construction of new spaces and monuments, but from a spatial ordering, and 2) revitalization that consists of the incorporation of constructed but largely remodeled spaces, in order to seek a supposedly lost vitality (economic, physical, cultural) as a result of the state of social chaos and disorder. In this sense, the revitalization process is a bet on the rescue of memories by the recovery and rehabilitation of decayed and degraded areas.

The fourth stage that underlies the strategic revitalization plan is related to its results in the short, medium and long term.

In the short term, the planning of urban space is planned with the opening of commercial houses, hotels, construction of residential buildings, creation of cultural and entertainment spaces, expulsion of certain social actors through the implementation of control and discipline actions. Often during this phase, ornamental objects are installed, changes of scenery by the incorporation of electrical networks, telephone, among others, expansion of spaces to facilitate the movement of surveillance and control agents and people, as well as vehicles, with the creation of spaces reserved for the official cars and determination of taxi stands.

In the medium term, vigilance policies are put in place to prevent the return of these social actors in order to maintain a safe functioning for the new social actors that circulate in the region and to avoid the scaring of these people, with measures that guarantee the maintenance of the embellishment and the high values of services and real estate. For this phase, coercive actions to the charge of state agents (municipal guard) and by the private initiative (people who exercise the role of Security Support) are taken over to control and surveillance.

In the long term, the great return of real estate speculation is expected with a considerable increase in the prices of rental and sale of real estate, which results in the ennoblement of the region. It is at this stage that the hygiene of the landscape is clearly evident by the concealment of the nets and the expulsion of undesirable people. In this way, the selectivity of the actors that can circulate in the revitalized space is established. However, in the same way that embedded networks continue to operate, social actors expelled, in the condition of memories that insist on being part of the place, can reappear at any moment. Therefore, the apparatus of coercion must always be in a state of alert, in order to guarantee the sense of order and also of cleanliness, once the actors who return were expelled for being accused of having bad habits and causing disorder and annoyance, such as informal street vendors, sex workers, traffickers, adults in situations of social abandonment.

The process of hygienization of space is quite selective, since with the expulsion of some social actors, others, with potential consumption, are in a position to accommodate themselves to the new and renovated facilities. In addition to the hygienization process, almost a kind of ethnic cleansing from the economic point of view, there is also the promise of devolution of the public space to the citizen in function of the improvement of flow conditions and the implementation of security systems, through the presence of coercive apparatus. As a result of this action, the region becomes a territory of selective use, but with tentacles, in relation to the perpetuation of memories, of those who have been uprooted, because even forcedly kept at a distance they are still part of the place where they lived great period of their lives.

The presence of the Municipal Guard, the Lapa Presente Program and agents paid for by the merchants, who are in fact a troupe of shocks, by intimidation (men of considerable physical size), prevent these non-desirable people from returning. This set of measures contributes to the revaluation of trade and to the increase of real estate values. At last it is a project that brings

security, beautification and comfort to a region, but which unfolds in economic figures due to the greater dynamism of commerce and also in the scope of real estate speculation. Therefore, it is necessary not only to expel the unwanted and surplus of consumption but also to maintain the continuous and selective control of the urban space. Certainly, in a region that has been transformed into the circulation of people with high purchasing power, Medical Legal Institute in that place was no longer acceptable. The transference of the Medical Legal Institute to another region of the city, removed from the eyes of the social actors the possibility of witnessing the continuous arrival of cars with corpses for necropsies in a street of great commerce, hotels and restaurants.

In the face of the above, it can be seen that there was a purge in the Lapa region, which happened in two main ways: by sending people to more remote neighborhoods or communities around the city, since they could not keep up in the face of the substantial increase in the cost of living in the neighborhood or by the removal of the population in street situation, public policy, without effectiveness, used to remove this population from the neighborhood in special circumstances. In this way, we can consider that the removal process is continuous and will continue until the day the authorities devise other modalities of action to solve the great problem of social inequality, using a method other than inequality itself. It is very common, due to the configuration of the new scenario by the arrival of people, to be triggered confrontations, either by estrangement to the new conditions of life, or due to the decisions taken by the state organs. That is, people who were formerly integrated into the neighborhood show signs of resistance in adapting to other regions, both through the rupture of previously established ties and the lack of assistance to build living conditions for the new environments, many of which are extremely precarious.

It is important to point out that these consequences are part of the knowledge of those who draw up master plans and also of authorities who, in function of economic interests, promote policies that only aim to remove these people from the tourist regions of the city without providing any real type of assistance. In this regard, we can ask: since the investment in these people does not represent any possibility of return to the public coffers is the City Hall really concerned about this issue? Certainly, because they are considered only living spectra, without any expectation of production, they are given to fate often living from the charity of people who, however uncomfortable, are mobilized, but not out of love or recognition.

The lens guided by legal devices often sticks to the vision of progress and aesthetic transformation. However, we cannot fail to point out that revitalization contains nuances that are truly outrages to the citizenship of people of certain social segments, especially those with low purchasing power who, if not necessarily removed from their social niches, will be due to the absence of conditions to stay in the modernized setting.

Although we situate a project that deeply affected the destiny of the people, it is known that the City Hall used revitalization to demote people and memories in favor of real estate speculation, and that little or nothing did to minimize the conflicts and issues that directly affected the population of the neighborhood. Certainly, the emphasis of the transformations was, for the most part, on changes in the economic sector and in the ambit of aesthetics. The people forced to leave Lapa due to the fact that they were not able to afford the cost of life suffered a high subjective setback due to the feeling of estrangement caused by the change of scene, because they settled in new spaces, being forced to live with people until then unknown.

V. CONCLUSION

The city of Rio de Janeiro, as a whole, in the last decades of the last century, has sourced its greatest process of decay, which can be considered on different fronts. First of all, there was a sharp rupture in its urban space with a clear separation, no longer in noble zones and poor zones, but zones that varied according to the level of violence. Secondly, the city center suffered many losses with the departure of offices from large companies to other capitals, the closing of the Stock Exchange and the creation of Administrative Regions in certain neighborhoods. Thirdly, as a consequence of this second aspect, there was an economic emptying, mainly due to a great atrophy in the political influences in the decisions of the Federal Capital. All these aspects represent the dissolution of the image projected world-wide in the beginning of century XX, from the Wonderful City image to a city of serious situations of life, mainly concerning security issues.

In an attempt of rescuing, the Lapa revitalization project resorted to an ideological discourse that concealed the proposal of a mercantile citizenship allied to the neoliberalist project. Lapa became, for a period, a valuable commodity that resulted in the circulation of large amounts of capital, but with a requirement to its inhabitants: the condition of citizen in the neighborhood is only assured by the power of consumption, decisive criterion for the inclusion of some and the expulsion of

others. In this way, the revitalization predetermined, from an economic variant, who truly is a citizen in the neighborhood, creating islands of selective excellence such as the famous condominium Cores da Lapa, oasis of well-being and consumption, but a residential space destined to very few people. Paradoxically to this island of excellence, there is still a degraded space in what has not yet been totally demolished from the Morro de Santo Antônio, a place of very little movement of people that serves as a place of housing for adults in situations of social abandonment and hiding place for those who carry out petty thefts. In this area, there are no security teams, as there are no commercial houses or sophisticated buildings.

The logic of expropriation of dwellings and removal of people by the Public Power hardly resonates with the life purpose of the actors to whom these operations are intended, since the geography of demolitions and removal of people is conditioned by rules, astutely established, that do not consider the heading of human rights. Certainly this positioning is due to the fact of prioritizing economic interests, in particular, the real estate market, which is the sector that benefits the most. It is important to point out that these interests are not often mediated by the public authorities, which suggests the possibility of increasing the number of cases with higher taxes.

The urban reform corresponds, to a certain extent, to a clear opening of the border for the expansion of the economic sector through restrictive measures that affect people with low power of consumption. These people experience the deleterious effects of these policies on their daily lives, without any option, for producing new strategies to change the precarious living conditions, especially exacerbated by the removal. Those people who can survive in such an adverse scenario are those who show signs of resistance. But there are others who settle, probably because of the lack of strength to engage in fighting movements.

As for the people who were removed and who settled in their new regions, there were changes in the economic situation, which, although it remained the same, made them to spend more money and time in transportation due to the distance of their jobs. They also had to cancel their projects of one day returning to live in their neighborhood, because they can hardly acquire a property or even rent it. In view of the above, we ask: what is the position of the State in relation to this situation? In fact, what was observed, for many people resettled, was the negligence of the Public Power. This process of coercion and abandonment applied in the name

of an aesthetic presentation of the neighborhood, justified for the attraction and reception of investors and the failed attempt to mitigate the violence produced irreparable subjective damages, without the sectors of the public power being in charge of policies of assistance to these people, since actions usually end with removal.

In the course of this reflection we draw a matrix to support our considerations: firstly, we find that the revitalization is based on a proposal concerning the production of a modernized and progressive image of the city, but focused exclusively on the market. As this is the priority of the reform, the spaces of the cities are adorned to be valued in the context of circulation of capital. Secondly, human rights are relegated to the background and often even considered. This is a very clear proposition: people who are expropriated and removed will hardly be able to enjoy the improvements promised by the reform, nor do they enjoy the benefits of the recovery resulting from the reform. In this way, we can deduce that these people are marginalized in the reorganization and requalification of the reformed region, in terms of occupation of the renovated spaces or by the possibility of access to the goods and services that are installed. From the remains, the process draws a clear demarcation line that distances significantly two groups: on the one hand, the partnership of the public power with the private initiative and, on the other, the former residents of these areas who insist on being present, even if it is in the debris.

This is the most obvious translation of the process of social segregation. We can affirm that revitalization works at two levels simultaneously: at the same time that it welcomes and concentrates people with consumption power, it pushes to the peripheries of cities those that, admittedly, do not fit into the logic of the capital market. That is to say, in a more accurate reading, we can admit that the people who inhabit a region before the revitalization are considered strange to the place, reason why they are removed because they are, according to the public power, outside the place where they should live: periphery of the city characterized by the abandonment full of pockets of poverty. We want to signal that these consequences are not a matter of luck, nor unknown to the idealizers of a reform, since they are foreseen in the Master Plans of revitalization, that is, they are the choices of the representatives of the state apparatuses. Therefore, to segregate and be segregated are steps of the same public policy and not completely unforeseen and unexpected results. Certainly, the agents responsible for the segregation process considerably

minimize the effects on the segregated persons, denying evidence and traces that are difficult to erase.

Finally, we would like to emphasize that the punctual or continuous removal of people has not been reversed and will not be reversed in an efficient strategy to completely wipe out the wreckage of poverty and solve the problem of social inequality; a situation very well illustrated by the population in a situation of social abandonment that, in the condition of indestructible remains reappear as living spectra in the different vestiges visible in streets, squares, viaducts, under the building marquises, churches. This scenario also counts on the presence of children and adolescents, in a situation of vulnerability that populate the streets, in traffic signs, selling food products. They are true tribes of the asphalt, in search of survival, that signal a state of disintegration.

This is a framework that is used constantly to accentuate poverty as a stigma or quality of certain people and not to see it as a real social problem, a legitimate expression of the marked inequality in our country, considering the sad statistics in which we are in the unequal countries of the world. According to the Human Development Report (HDR), prepared by the United Nations in 2017, Brazil is the 10th most unequal country in the world. Certainly, we have to revitalize regions of our cities, but before that we need the management authorities of our country to reflect, with other instruments, on the problem of social inequality: there is no point in avoiding the problems, since we must face them in order to solve them.

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REFERENCES

- [1] ARAÚJO, V. J. (2009). Lapa Carioca, uma (re) apropriação do lugar. Dissertação (Mestrado) - Curso de Pós-graduação em Planejamento Urbano e Regional, Universidade Federal do Rio de Janeiro, Rio de Janeiro.
- [2] FURTADO, C. R. (2014). Intervenção do Estado e (re) estruturação urbana. Um estudo sobre gentrificação. Cadernos Metrópole. v. 16, n. 32, pp. 341-363.
- [3] GEVEHR, D. L.; BERTI, F. (2017). Gentrificação: uma discussão conceitual. Políticas Públicas & Cidades. v. 5, n. 1, pp. 85-107.
- [4] GOIS, M. P. F. A gestão da noite urbana carioca: entre discursos sobre ordem urbana e práticas socioeconômicas. Sociedade e Natureza. v. 26, n. 2, pp. 221-235, 2014.

- [5] HARVEY, D. (1996). Do gerenciamento ao empresariamento: a transformação da administração no capitalismo tardio. *Espaços & Debates*. v. 39, pp. 48-64.
- [6] LESSA, C. Os ovos da serpente. In: BURSZTYN, M. (Org.) (2000). *No meio da rua: nômades, excluídos e viradores*. Rio de Janeiro: Garamond.
- [7] LESSA, C. (2001). *O Rio de todos os Brasis*. Rio de Janeiro: Record.
- [8] MACEDO, M. A. M. (2004). A concepção do projeto corredor cultural do Rio de Janeiro: a participação de técnicos e intelectuais no processo de planejamento urbano. *Seminário de História da Cidade e do Urbanismo*, v.8, n.4, p.1-15.
- [9] MBEMBE, A. (2017). *Políticas da inimizade*. Lisboa: Antígona.
- [10] RIBEIRO, T. F. (2018). Gentrificação: aspectos conceituais e práticos de sua verificação no Brasil. *Revista de Direito da Cidade*. v. 10, n. 3. pp. 1334-1356.
- [11] SANTOS, M. (2014). *Metamorfoses do Espaço Habitado*. São Paulo: Edusp.
- [12] SMITH, N. (2007). GENTRIFICAÇÃO: A fronteira e a reestruturação do espaço urbano. *GEOUSP: Espaço e Tempo (Online)*, São Paulo, n. 21, p. 15-31.
- [13] VENTURA, Z. (1994) *Cidade partida*. São Paulo: Companhia das Letras.
- [14] WACQUANT, L. (2007). *Punir os pobres*. Rio de Janeiro: Revan.
- [15] XAVIER, A. et al. (2012). Projeto Lapa Legal: intervenção urbana e gestão em área de proteção do ambiente cultural. *Rio Patrimônio Cultural*. Ano 2, n. 1, pp. 7-17

Cost Reduction in Soybean Production Through Automation of the Water Capture System Using the M2M Communication Protocol

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Abstract— Waste water is a much debated problem, for various reasons such as economic, technological, political and political causes, involving different stages of production. This article has as main objective the analysis of the automation of the system of abstraction of water through the communication protocol M2M in a food company of the state of Minas Gerais - Brazil. The study is based on production line data before and after the application of the tool. The choice of the process of propitiate a better quality of life for the users is justified by the modernization of the relationship between man and machine. Analyzing the obtained results, it is concluded that the main one of the work was also prosperous, having been possible the implantation of M2M data protocol of Industry 4.0 and its branch in the process of production and reduction of cost.

Keywords— Industry 4.0, M2M, Soybean juice production.

I. INTRODUCTION

This article describe the concepts of Industry 4.0 and the steps taken to implement the procedure, through studies and results obtained in a company of the Industrial Pole of Minas Gerais - Brazil. presents an automated system of water abstraction in the production of soy juice in the plant through the M2M (Machine-to-Machine) communication protocol.

Before without this information of water levels in the reservoirs, the company stored water in trucks kite generating unnecessary costs. Now with the M2M communication protocol providing the necessary data in real time, the inventory was excluded from the cost planning and the purchase is only carried out in cases of production above the capture capacity.

The benefits achieved with automation are clear, real-time decision-making by production engineers is more effective because data capture, use and storage are available simultaneously, so the predictability of water purchase becomes decisive element in the reduced cost of production.

In this direction, the general objective is to analyze the efficiency in the implementation of the automation system that communicates through the M2M protocol in a food business. In addition, its specific objectives were: Describe the implementation process of the M2M communication protocol; To understand how the process of reducing the cost of water abstraction for soybean juice production through the M2M communication protocol.

II. METHOD

The research presented here has as basic assumptions to describe about the industry 4.0, the 5W2H and PCDA methods; the M2M communication protocol and the soy juice manufacturing process, as well as other concepts within this contextualization, themes that are present today.

According to [1], the fourth industrial revolution has started and firms are running out of time to be part of Industry 4.0. The industry scanning process includes a physical network with connected devices, tools and platforms with features that involve technology to share intelligence with each other and communicate with the outside environment and with people.

2.1 METHOD 5W2H

5W2H is a methodology used to elaborate action plans, being objective and simple in orientation to action, being very applied in Business Analysis, Project Management, Strategic Planning, Elaboration of Business Plans, and in other management disciplines. The main purpose is to establish that all activities to be carried out, be programmed in an objective way, enabling the execution in a totally organized way.

According to [2], the 5W2H tool allows to detect the most relevant routines of the project, process or even of a production sector. It also makes it possible to verify who is who within the organization, what it does and why it performs such activities.

2.2 PDCA METHOD

The PDCA Cycle is a management system widely used by companies. According to [3]. Generally represented as a circle, formed of four stages which represent: "Plan" - to plan; "Do - do; "Check" - check; and "Act" - actuate or adjust.

In an interesting approach, [4] approaches the use of quality tools in the food production process and the execution of audits as a way of maintaining and improving the system.

According to [5], the PDCA Cycle is a tool used for the application of process control actions, such as establishing the "control guideline", quality planning, maintenance of standards and alteration of the control guideline, and to make improvements.

2.3 M2M COMMUNICATION PROTOCOL

The M2M is a protocol of communication between man and machine, with the purpose of controlling production processes remotely, using instruments of last generation, that internally have converters of signals that use its protocol for data exchange, which allows the control in real time of all the equipment that are interconnected in a communication network through a pair of cables.

According to [6], M2M presents a flexible scope and with some defined limits. It describes M2M as follows:

The role of M2M is to establish the conditions that allow a device to exchange information (bidirectionally) with an application over a communication network, so that the device and / or application can act as the basis for this exchange of information [6].

The M2M communication protocol is transmitted by an equipment connected to one or more machines, forwarding information in real time. The data is collected and controlled by the worldwide INTERNET computers network. Unlike the process of telemetry, where everything is done wireless, the M2M system can be used chips, drivers and among others, diversifying according to the priority and goal to be achieved by the company.

[7] Acompanhado por uma tentativa de classificação de pesquisas existentes sobre M2M, propõe uma exposição de desafios e oportunidades de pesquisa aberta que abrangem as diversas facetas da comunicação M2M. [8] Destaca a aplicação do m2m na aplicação da internet das coisas, aborda temas em que os usuários relutam em confiar no sistema centralizado para suas informações privadas, garantir a privacidade sem um sistema confiável é uma propriedade essencial do sistema de reputação, um sistema de reputação descentralizada que preserva a privacidade é proposto; o sistema garante privacidade e correção em modelos de ameaças padrão.

[9] em uma pesquisa sobre ameaças e soluções de segurança da informação para comunicações Machine to Machine (M2M), destaca uma análise detalhada das ameaças e soluções de segurança da informação para comunicações M2M; desafios de pesquisa e questões de pesquisa aberta em comunicações M2M; e uma revisão do padrão oneM2M. [10] em seu trabalho tecnologias de comunicação sem fio máquina a máquina para a Internet das coisas: taxonomia, comparação e questões abertas, pretende organizar as abordagens e tecnologias M2M existentes em uma estrutura consistente que forneça uma visão aprofundada das principais tendências, direções futuras e questões abertas.

[11] propõe novo protocolo de consenso de confiança e sistema de avaliação de confiança baseado em blockchain para serviços de aplicativos M2M. [12] em seu trabalho fornece uma revisão abrangente do potencial robótico que é previsto pelos pesquisadores na criação de uma futura fábrica de alimentos. Destaca que configuração atual de manuseio e embalagem de alimentos é limitada em capacidade e produção devido ao processamento manual.

2.4 PROCESS OF MANUFACTURE OF SOY JUICE

Soy juice is a beverage produced from soybeans, and it adds flavor essences planned by the company. The juice is derived from soy milk, which is a good source of protein and fiber, easily digestible, containing less fat than cow's milk and cholesterol-free. It is very consumed by people with high cholesterol, by the juice does not contain cholesterol, by vegans, people intolerant to lactose, diabetics, by possessing low content of carbohydrates. In making this beverage the soy beans are inserted in water and ground. Then the dough is cooked to destroy the toxins that make it impossible to absorb the proteins. After fermentation is filtered and soy milk is obtained. After the feat is inserted the essence of varied flavors.

III. EQUATIONS

The research used a qualitative approach, since there was a need for interpretation of the phenomena and attributions of meanings.

3.1 PARTICIPANT

The case study happened with an employee of approximately 38 years of age, who works in the area of Engineering and Maintenance. The same experienced the process of implementation of the project, from the automation of the water system, whose new technology interconnected via optical fiber and M2M protocol. All data from the water collection and reservoir system were

concentrated in a central PLC (Programmable Logic Controller), and in this central PLC, a closed-loop PID (Proportional Integral or Derivative) control logic was placed, which from the consumption of the final customer of the soybean juice sector, accelerates or decelerates the water pickup pumps.

3.2 TECHNIQUE FOR DATA COLLECTION

An interview with open questions was used. According to [13], the interview is configured as a conversation between two people, with pre-established purposes. It is still a very important form of communication, giving a unique meaning to verbal language.

By the possibility of interaction between the interviewee and the interviewer and depth about certain subjects, the semi-structured interview was chosen. For [14], interview allows the interviewer to get closer to the interviewee and favors a much closer and more affective relationship between both parties, thus allowing the collection of sensitive and complex issues involving the participant.

As part of this technique, an interview script was prepared previously, whose questions were directed so that through the participant's speech it was possible to answer the research questions.

3.3 PROCEDURE

The research was carried out in the first half of the year 2019. Through the implementation of the automation of the water system from the interaction of M2M data in the soybean juice manufacturing process, in a food company. In the dialogue that took place between the parties, a semi-structured interview was conducted, with open questions directed, the interview was recorded, and later transcribed, to facilitate the analysis of the data.

IV. RESULTS AND DISCUSSION

From the data collected in the interview with the collaborator, the description of the implementation of the M2M protocol was made, as well as, from the reports, as well as through tables, demonstrates the effectiveness of the protocol of communication of data M2M, in the reduction of cost in the manufacture of soy juice at the company surveyed.

4.1 IMPLEMENTATION OF THE M2M PROTOCOL

After reports of workers concerning the difficulties encountered in their functions, the PCP (Production Planning and Control) sector together with Production and Development Engineering, went to the market to find technologies that would help them to maximize water abstraction from the groundwater, due to an excessive

expenditure and several interruptions in the production line, whose raw material depends exclusively on a large reservoir of water.

Thus, production engineers came to the conclusion that they needed a real-time information system to aid in decision-making, quantity production and water supply.

In this context, a joint study of the Quality, Engineering and PCP sectors was carried out, and they concluded that they needed to change the existing technology in the company's electrical panels, since the same one came from industry 2.0 (production in mass-technology totally electric) did not have autonomy of operation, that is, the water intake was only activated when the reservoir was low and later, it activated a sensor in the bottom of the water reservoir thus losing two (02) of abstraction to each reservoir.

In this perspective, the main objective of the company was to switch from the technology of panels previously based on Industry 2.0 to Industry 4.0, where the equipment communicates in real time through an M2M protocol.

Deployment occurred by the following steps:

Step 1 - All existing technology was changed, which consists of the implementation of PLCs and signal converters with the communication capability via Ethernet (M2M) in the electric control responsible for the activation of the pumps in both the wells and in the boxes.

Step 2 - Afterwards, the electric buoys were moved by a pressure sensor in the boxes. This allows the immediate sending of the boxes (180m³ and 360m³) through the signal sent via optical fiber. These sensors with the communication capability via Ethernet (M2M) can detect a change in millimeters (mm) at the level of the boxes. Previously it was only possible to check the full box signal and the empty box.

Step 3 - Next, the flow sensors were installed at the water outlet for the final sectors (consumption) with the communication capability via Ethernet (M2M).

Step 4 - Installation of an optical fiber was performed by connecting all panel converters, thus closing an Ethernet (M2M) communication network and interconnecting in the central computer.

Step 5 - Lastly, Rockwell's Software Studio 5 was installed on the central computer to receive all data from the network and connect to the supervisory control system of the company.

It is noteworthy that in the company surveyed, the experience and experience of some employees who know about the reality of the work, and for detecting some difficulties, sought the engineering service for possible solutions to the problems. In this perspective, the

company sector responsible for the implementation of projects, sought ways to solve the problem, and knew the benefits of the M2M protocol. So, they decided to deploy it without even applying a tool that accurately presented a diagnosis, so they only relied on the look of collaborators who know about the process.

In this context, looking from the perspective of engineering, even as a suggestion, if other companies decide to walk in this direction. For the automation of the water abstraction system through the M2M communication protocol, it is recommended that although it considers the observations of employees who act directly in certain functions, understanding and not demeaning, since it is understood that they really know about their work, its function, however, for the benefits and veracity of the results, that the companies realize the application of the PDCA cycle tool and the 5W2H method. This can be applied in stages, and is an instrument capable, along with other quality tools, to detect the possible root causes at various stages of the information gathering process, always taking into account the provenance or effective quality of the procedure within any organization. job.

In this sense, what is proposed for companies, above all, is to be applied an effective management tool, to promote and facilitate means of implementation of projects thus collaborating with the environment and above all in reducing costs.

4.2 EFFECTIVENESS OF THE M2M DATA INTERACTION PROTOCOL IN COST REDUCTION.

It was realized the need to change the technology of the panels before, based on Industry 2.0, which was an outdated and strictly electric technology, which did not allow the control of the wells concession, let alone supply 100% the demand of the production in the consumption of water for Industry 4.0. Thus, new paths were sought in 2017, because of the growing demand for production, which resulted in a high consumption of water. An obstacle occurred because the control over the concession presented difficulties for the water economy to occur, since the company acted in approximately sixteen hours of suction, for twenty-two days a month in which they were released for suction.

It was noticed that the water box buoys made it impossible to use the well efficiently because it was deactivated until reaching the minimum level of water, only activating the pumps of the wells with the level reached. However, there was the big problem, since the permitted suction flow of the wells was 39m³ and the production consumption was 90m³, when the wells were activated, the level was too low to produce, in a dilemma,

or stopped production or stocked water, there was an unnecessary cost.

Thus, with the implementation of the project in which the upgrade of the panels and sensors were present, everything connected via optical fiber to a central computer with the Studio5 software, being autonomous and with PID logic in closed loop. The output water flow sensor for the production commanded real-time pump speeds of the 180m³ box, as well as 360m³ box suction pumps, and also commanded the suction pumps from the wells.

In short, the closed-loop PID makes suctioning of the wells only happen when the end customer is using, and at the flow rate he is using. It is emphasized that it is necessary that the water boxes always stay at the maximum level or near to it, so that the water is made from the consumption. With this, it is pertinent, visible the effectiveness of the project, since since its implantation not a single liter of water was bought and also the limits of the granting, imposed by the Brazilian Institute of the Environment have never been broken. The tables below demonstrate precisely the decrease in expenses.

Table 1 – Comparison Buy x Production

BUY WATER X PRODUCTION JUICE				
Year	Year 2017		Year 2018	
MONTH	BUY WATER IN M ³	PRODUCTION JUICE M ³	BUY WATER IN M ³	PRODUCTION JUICE M ³
jan	915	12500	0	140000
feb	920	13500	0	155000
mar	800	12100	0	155000
apr	700	11950	0	100000
mai	725	12050	0	130000
jun	830	12150	0	145000
jul	810	12180	0	155000
aug	750	12060	0	120000
sep	800	12100	0	120000
oct	920	13500	0	150000
nov	680	11800	0	145000
dec	650	11600	0	160000
TOTAL	9500	147490	0	1675000

The table 1, shows that since the implantation, there was no purchase of water, reducing the expense, there was also increase in the production of soy juice.

V. CONCLUSION

Among the various possibilities, the M2M communication protocol presents itself as an investment that collaborates and can change the culture of water waste. The automation of water systems via M2M protocol, an effective tool in cost reduction in the production of the company surveyed. It was noticed that

the implantation provided in its installation, not only the reduction of cost, but also, it generated information in real time facilitating, thus, the decision making of the engineering sector. The M2M communication protocol was a useful tool for point-to-point communication in the sectors and the sending of data.

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An acknowledgement section may be presented after the conclusion, if desired.

REFERENCES

- [1] SCHWAB, Klaus; DAVIS, Nicholas. Aplicando a quarta revolução industrial. EDIPRO, 2019.
- [2] CAMPOS, Vicente Falconi. TQC: Controle da Qualidade Total (no estilo japonês). Universidade Federal de Minas Gerais, Escola de Engenharia, 1992.
- [3] GOBIS, Marcelo Aparecido; CAMPANATTI, Reynaldo. Os benefícios da aplicação de ferramentas de gestão de qualidade dentro das indústrias do setor alimentício. HÓRUS, v. 7, n. 1, p. 26-40, 2017.
- [4] GOBIS, Marcelo Aparecido; CAMPANATTI, Reynaldo. Os benefícios da aplicação de ferramentas de gestão de qualidade dentro das indústrias do setor alimentício. HÓRUS, v. 7, n. 1, p. 26-40, 2017.
- [5] WERKEMA, Cristina. Métodos PDCA e Demaica e Suas Ferramentas Analíticas. Elsevier Brasil, 2013.
- [6] BOSWARTHICK, David; ELLOUMI, Omar; HERSENT, Olivier (Ed.). M2M communications: a systems approach. John Wiley & Sons, 2012.
- [7] AMODU, Oluwatosin Ahmed; OTHMAN, Mohamed. Machine-to-machine communication: An overview of opportunities. Computer Networks, 2018.
- [8] AZAD, Muhammad Ajmal et al. M2M-REP: Reputation system for machines in the internet of things. Computers & Security, v. 79, p. 1-16, 2018.
- [9] TUNA, Gurkan et al. A survey on information security threats and solutions for Machine to Machine (M2M) communications. Journal of Parallel and Distributed Computing, v. 109, p. 142-154, 2017.
- [10] MONTORI, Federico et al. Machine-to-machine wireless communication technologies for the Internet of Things: Taxonomy, comparison and open issues. Pervasive and Mobile Computing, 2018.
- [11] SHALA, Besfort et al. Novel Trust Consensus Protocol and Blockchain-based Trust Evaluation System for M2M Application Services. Internet of Things, p. 100058, 2019.
- [12] KHAN, Zeashan Hameed; KHALID, Azfar; IQBAL, Jamshed. Towards realizing robotic potential in future intelligent food manufacturing systems. **Innovative food science & emerging technologies**, v. 48, p. 11-24, 2018.
- [13] DE SOUZA-MINAYO, Maria Cecília. Ciência, técnica e arte: o desafio da pesquisa social. de Souza-Minayo MC, compilador. Pesquisa social: teoria, método e criatividade, v. 23, p. 9-29, 2000.
- [14] BONI, Valdete; QUARESMA, Sílvia Jurema. Aprendendo a entrevistar: como fazer entrevistas em Ciências Sociais. Em Tese, v. 2, n. 1, p. 68-80, 2005.

The Comparative study of ICT equipment preventive maintenance with Corrective maintenances: In case of Wolaita Zone

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Abstract— In most rural and semi-urban, people purchasing ICT equipment per each budget years. And after purchasing the devices they should have assign budget to repair fix, maintain the devices. In our study we are focusing on the types of maintaining and feasibility of the type of maintenances. In this study we have done our project work for the last three years in preventions rather than repairing the broken parts. And the study is helpful for the community of the Semi-urban in Wolaita Zone, Ethiopia. In our catchments area of the project we have implemented in more than 360 staffs of the district or Woreda. So, we are focusing to show the differences and effectiveness of the preventive maintenance rather than corrective maintenance for the ICT equipment.

Keywords— Corrective maintenance, ICT equipment, machine, preventive maintenance, Repair, Woreda.

I. INTRODUCTION

Maintenance can represent a significant portion of the cost in asset intensive organizations, as breakdowns have an impact on the capacity, quality and cost of operation[1]. ICT equipment describes various steps to keep your electronic machine functioning at an optimal performance level from a software and hardware point of view.

ICT Equipment Preventive Maintenance is a schedule of planned maintenance actions aimed at the prevention of breakdowns and failures for the ICT Equipment like printer, Fax, Photocopy, computer hardware or software and others to help ensure it continues to operate properly. In Remote Areas cannot afford for their technology to fail them. Even a short amount of computer downtime can lead to a huge loss of productivity and information, not to mention patience[2]. In order to ensure you are keeping your computer firing on all cylinders the same things for all ICT equipments could be happened. We have prepared very essential cures for the failure of devices .this way is also the best maintenance way in ICT. This types of maintenance we had implemented in our community for the last 3 years and the product is really valuable as based on the feedback we

got from the different offices of Wolaita Zone rather than ICT equipment corrective maintenances. ICT equipment Corrective maintenance is defined as the maintenance performed to return equipment to proper working order. Depending on the context of its use it may refer to maintenance due to a breakdown, or maintenance identified through a condition monitoring program[3].

In general Preventive maintenance is the scheduled maintenance for the machine before failure, but the Corrective as the fixing the machine after failures [4]

And also, Preventive maintenance issues considers the care and handling of the devices in well manner and the corrective is the most errors occurred or happened in the case of miss handling the devices.

In our study we have visited 6 districts out of 15 from the Wolaita Zone, and we communicated with the District/Woreda officers, In each district or Woreda have 24 sectors and they have at minimum computers, copiers, printer, Fax, Plasma TV and etc.. In each sector in one weredas can hold 10% of annual budget for the Maintenance, but they have no awareness how to handle and make the scheduled maintenance to operate the device

in working conditions. But they are losing data, in case of corrective maintenance, shortages of machine life or durability in mishandling, office job instability, and unreliability in machine, costly by paying the repair parts and professional payment.

II. METHODOLOGY

i. Trainee Selections Methods

We have given the training for selected six(6) known districts/ woreda from the Wolaita namely Bolosso Sore, Damota Woyde, Kindo Koysa, Damota Sore, Damota Pulassa and Ofa Districts. In our project, all sectors that use ICT equipment should have implement preventative maintenance measures. because of the Woredas are most semi urban, remote and less numbers of ICT professionals.

By considering these reasons we had planned to trainee Preventive Maintenance of ICT equipment in the five weredas. The Trainee offered for 24 sectors per Woreda and Per sector we will select 1 Human Resources(HR) and 1 secretary as well as 2 others. Therefore, the training is expected to give 50 trainers per Woreda and the total numbers of trainers for Six selected woredas had been $6*60= 360$ trainee from Wolaita zones in 2016/17, 2017/18 and 2018/2019 annual project budget years of Wolaita Sodo University.

The reasons for selecting the HR and office secretary are the office secretary is responsible for the machine she

handles and also installing the updated antivirus. And also the HR is responsible to hire the professionals and specify the good ICT equipment specifications to purchase and also maintain.

ii. Machines specifications in our project

The machines that we mentioned in the above Computer, printer, Copier, DSL, Power stabilizer, Scanner, Fax and others are there in each sectors of the Woredas. The expected machines per sectors is at least 20 and above Then; The Woreda expected machine is at minimum $20*24=480+$ (is the machines from 2 High schools and ICT offices in the total woredas out of 2400:

iii. The Project works:

The training given for the staffs of 300 registered and 60 unregistered from the Wolaita zonal administrations in 6 district/Woredas. Regarding, the preventive maintenance in both hardware and software level for the 15 days in each district. The project budget sponsored by Wolaita Sodo University Ethiopia for the last 3 consecutive research budget years.

iv. Supervisions and feedback

After the end of each training we visited the districts, we collected the feedback before and after.



III. DISCUSSIONS AND RESULTS

The study implemented by using different methods that we have mentioned in above. To get the results we have given training in the area of topics listed under here for the staffs in the topics under the preventive maintenances. [5]

No	Easily trained the preventive maintenance	Effectively operated trainee out of 360
1	Using the computer account creating, folder creation, and management	300
2	Handling offices and machines properly	200
3	Cleaning your computer hardware.	200
4	Preparing the purchasing machine specifications	100
5	Downloading the latest drivers for your hardware.	200
6	Downloading the latest updates for your computer software.	200
7	Verifying you have the latest anti-virus protection updates on your computer.	200
8	Running disk software utilities such as defrag and Scandisk on your hard drive.	300
9	Deleting unused programs or other files on your computer.	350
10	Switch off and Reboot the machine properly	350
11	Using power stabilizers to stabilize the power	200
12	Creating the suitable places for office machines/ICT derives	250
13	Office layout standard	250
14	Furniture and facility required for the ICT electronics	250
15	Creating the dust free environment for ICT electronics	250
16	Stabilized power usage for the machines	200
17	Installing the softwares, OS and antivirus	250

We have easily trained staffs in each district to take preventive maintenance, therefore they have awareness how to use take the action on the ways of prevention. Based on their feedbacks and our supervisions we found great impact on machine operations, the stability of the machines in the offices of Woreda in Zone.

IV. CONCLUSION

When we compare the preventive maintenance with corrective maintenance; there is a big difference. So, we concluded our study based on the following mentioned advantages over the corrective one.

- ✓ Anybody without maintenance professionals can take the prevention
- ✓ Worthwhile maintenances compared with others.
- ✓ This type of maintenance saves the maintenance cost for each officer.
- ✓ Using the preventive maintenance makes the machine is durable, reliable and stable data in organizations.

REFERENCES

- [1] G. Waeyenbergh and L. Pintelon, "A framework for maintenance concept development," *Int. J. Prod. Econ.*, vol. 77, no. 3, pp. 299–313, 2002.
- [2] N. Saleh, A. A. Sharawi, M. A. Elwahed, A. Petti, D. Puppato, and G. Balestra, "Preventive maintenance prioritization index of medical equipment using quality function deployment," *IEEE J. Biomed. Health Inform.*, vol. 19, no. 3, pp. 1029–1035, 2014.
- [3] M. A. K. Malik, "Reliable preventive maintenance scheduling," *AIIE Trans.*, vol. 11, no. 3, pp. 221–228, 1979.
- [4] "What is Corrective Maintenance? (Definition & Examples)," *Fiix*.
- [5] R. Barlow and L. Hunter, "Optimum preventive maintenance policies," *Oper. Res.*, vol. 8, no. 1, pp. 90–100, 1960.

Quality of Life in Students of Medicine of the University of Gurupi-TO

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Abstract—Introduction: Medical academics face many difficulties in meeting the training requirements. The difficult routine with intense hours of study, lack of time to carry out leisure activities compromises the quality of life of this public. Objectives: To evaluate the quality of life (QoL) of academics and academics of the medical course of the University of Gurupi-TO. Materials and methods: We included students over the age of 18, from the 1st to the 8th period, who agreed to voluntarily participate in the study. To evaluate the quality of life, the WHOQOL-BEF questionnaire was used. The data collected were inserted into a Microsoft Excel 2019 spreadsheet and the calculations followed the standards established by Pedrosa et al., 2010 [1]. The statistical analysis of group comparison was performed using SPSS software, version 19 from the test protocol of Student. The tests were performed with a significance level of 5%. Results: 140 students participated in the study, in which 54.28% were female and the other 45.72% were male. As for the self-evaluation of the quality of life, the students presented a total average of 14.41, while the average between the male and the female were 14.52 and 14.11 respectively ($p=0.166$). The mean QoL scores of the four domains were 14.59 for the physical domain, 14.12 for the psychological domain, 14.50 for social relations and 13.96 for the environment. When analyzing the differences between genders, it was observed significantly in the physical ($p=0.001$) and psychological ($p=0.017$) domains, with men being better classified than women. Conclusion: It is concluded that the QoL of medical students is average and high, however, male students have better QoL when compared to women in the physical and psychological domains.

Keywords—Quality of life, Students, Medicine.

I. INTRODUCTION

The concept of quality of life is a modern construct and an old concern since the idea of living with quality was already present in antiquity. Aristotle in 384 and 322 BC referred to the association between happiness and well-being. Hippocrates in 460 and 370 BC and Galen in 132 and 200 AD argued that balance supports a healthy body [2] (FIEDLER, 2008). In the 1990s, the World Health Organization (WHO) defined QoL as "the individual's perception of their position in life, in the context of the culture and value system in which they live and in relation to their goals, expectations, standards, and concerns" (WHO, 1998) [3].

Quality of life is assessed from questionnaires, the most used are WHO, WHOQOL-100 and WHOQOL-BREF, these two questionnaires have questions related to the quality of life in general and some domains. The physical domain includes aspects about the presence of pain and discomfort, energy and fatigue, sleep and rest, mobility, activities of daily living, dependence on medication or treatments and work capacity. The

psychological domain correlates with positive feelings, self-esteem, negative feelings among others. There are also questions about personal relationships, emotional support, physical security and protection, financial resources, health care, and other aspects that are involved with the domains of social relationships and the environment.

According to Araújo et al. (2014) [4], since the arrival of the student in the university, most of them young, in the process of change, carrying with them doubts and uncertainties about their adaptation in the academic environment, the university is vulnerable to the stress caused by the college. Part of these concerns is due to the fact that the central object of work of this future professional will be related to the needs of prevention, promotion or recovery of the health status of the human being. Such a concern is clearly expressed in the National Curricular Guidelines of Nursing, Medicine and Nutrition Undergraduate Courses, which require the university to have competent, humanistic, ethical, critical and reflective professional training [5] (BARALDI et al., 2015).

According to Carvalho et al. (2017) [6], health courses, such as dentistry, were recognized as a source of stress during the training of their students, affecting the physical and mental well-being of the students due to pressure from activities, examinations and acquisition of knowledge, professional skills and attitudes, financial concerns, sleep deprivation, and exposure to patient suffering and death. Accordingly, Chazan and Campos (2013) [7] evaluated the quality of life of 394 UERJ medical students in 2010, the mean QOL reported was 66 and the health satisfaction 62. The lowest QOL scores were observed in female students, with reported chronic morbidity. This is due to the perception that medical students are constantly influenced by stressors [8] (FIGUEIREDO et al., 2014). The pressure begins with the competitiveness of the college entrance examination and extends the teaching methodology, full-time course, the relationship of academic activity with leisure and social aspects [9] (Aguar et al., 2009), the requirement of high income, volume of information, contact with sick people and death [10] (BAMPI et al., 2013). The framework described implies, increasingly, the quality of life of graduates of this course [11] (FEODRIPPE; BRANDÃO; VALENTE, 2013).

According to Bampi et al. (2013) [10], the medical students of the University of Brasília obtained social relations as the best-evaluated domain and the psychological one with the worst score. The facets sleep, energy degree, ability to perform day-to-day activities, acted negatively on the quality of lives of academics, in agreement with the study Figueiredo et al. (2014) [8] who, after analyzing the factors that determined the quality of life of medical students at the Federal University of Ouro Preto, concluded that the extensive curricular workload associated with excessive extracurricular load impaired the practice of sports, leisure and sleep quality, negatively influencing the interviewee. In contrast, Cunha et al. (2017) [12] despite being in agreement with Bampi et al. (2013) [10] on social relations as the best score, reported that the worst score in his research was the physical domain. In addition to this finding, Cunha et al. (2017) [12] also state that males had a higher QoL score when compared to females, as did Chazan and Campos (2013) [7].

Taking into account all the considerations made so far and seeking a better understanding of this complex subject, the present study aims to evaluate the quality of life of the medical students of the University of Gurupi — TO in different domains and in the general quality of life, in addition to comparing the differences between the sexes.

II. MATERIALS AND METHODS

This is a quantitative descriptive study carried out with undergraduate medical students from the University of Gurupi, an institution located in the south of Tocantins state, from April 2018 to February 2019. The present study was submitted and approved by the Research Ethics Committee of the Institution of Higher Education (CAAE 86994718.8.0000.5518), and all subjects who participated in the research read and signed the Informed Consent Term (TCLE).

The study included 140 students, from the 1st to the 8th period of the medical course, at the University of Gurupi, aged 18 years or over. The WHOQOL-BREF questionnaire was used for the evaluation of QoL of UnirG medical students. It is composed of 26 questions, in which the first one refers to the perception of the general quality of life and the second about satisfaction with one's own health. The other 24 questions are distributed in four domains: physical (seven questions on pain and discomfort, energy and fatigue, sleep and rest, mobility, daily life activities, use of medications and work capacity), psychological (six questions on feelings positive and negative, thinking and learning, memory and concentration, body image and spirituality), social relations (three questions about personal relationships, social support and sexual activity), environment (eight questions about physical security and protection, home environment, financial availability, and quality of health and social care, opportunities to acquire new information and skills, leisure activities, physical environment and transportation).

All questions have five Likert type response options, and the fifteen days prior to self-completion of the instrument should be considered, with ten to fifteen minutes. The questionnaires were always applied by the same researchers who were previously trained. The data collected from the WHOQOL-BREF questionnaire were inserted into a Microsoft Excel 2019 spreadsheet, all calculations follow the standards established by Pedrosa et al., (2010) [1]. For the analysis, SPSS software version 19 was used from the protocol Student's t-test. The tests were performed with a significance level of 5%.

III. RESULTS AND DISCUSSION

In the table below (table 1), the results concerning the quality of life domains, separated by sex and the total sample, are presented 140 students participated in the study, in which 54.28% (n=76) of the interviewees were females and the other 45.72% (n=64) males.

As for the question of self-rated quality of life, the students presented a total mean of 14.41, while the

average between the male and the female was 14.52 and 14.11 respectively (p=0.166).

Considering the total sample of students, the mean QoL scores of the four domains of the WHOQOL-BREF questionnaire were 14.59 for the physical domain, 14.12 for the psychological, 14.50 for social relations and 13.96 for the middle environment, thus obtaining the best index for the physical domain and the worst for the environment when comparing the domains with each

other.

When analyzing the differences in QoL between genders, it was observed that males presented higher averages in all domains, with a significant difference in the physical (p=0.001) and psychological (p=0.017) domains. The highest mean area of the investigated group was the physical one (14.59±2.41), the highest mean was in the physical domain (15.56±1.81), while the female had the highest mean domain social relations (14.30±3.59).

Table 1: Quality of life outcome.

VARIABLE	Sex		Totaly (140)	Value p
	Men (64)	Woman (76)		
Physical				
Mean ± SD	15,56 ± 1,81	14,00 ± 2,58	14,59 ± 2,41	0,001
Median (min.; max.;	15,43 (11,43; 18,29)	14,29 (8,00; 20,00)	14,86 (8,00; 20,00)	
CV (%) - amplitude	0,12	0,18	0,17	
Psychological				
Mean ± SD	15,28 ± 2,20	13,63 ± 2,77	14,12 ± 2,66	0,017
Median (min.; max.;	15,20 (9,60; 18,40)	13,60 (7,20; 18,40)	14,40 (7,20; 19,20)	
CV (%) - amplitude	0,14	0,20	0,19	
Social relationships				
Mean ± SD	14,97 ± 2,73	14,30 ± 3,59	14,50 ± 3,33	0,426
Median (min.; max.;	14,67 (6,67; 20,00)	14,67 (4,00; 20,00)	14,67 (4,00; 20,00)	
CV (%) - amplitude	0,18	0,25	0,23	
Environment				
Mean ± SD	14,03 ± 1,78	13,80 ± 2,45	13,96 ± 2,26	0,379
Median (min.; max.;	14,50 (10,00; 17,00)	14,00 (7,50; 18,50)	14,00 (7,50; 18,50)	
CV (%) - amplitude	0,13	0,18	0,16	
Self-assessment QoQ				
Mean ± SD	14,52 ± 2,63	14,11 ± 3,36	14,41 ± 2,95	0,166
Median (min.; max.;	16,00 (6,00; 20,00)	14,00 (8,00; 20,00)	14,00 (6,00; 20,00)	
CV (%) - amplitude	0,18	0,24	0,20	

SD: standard deviation; min.= minium; max.= maximu m; CV= coefficient of variation; QoQ= quality of life.

The objective of this study was to evaluate the quality of life (QoL) of the medical students of the University of Gurupi - TO and to compare the gender differences in the quality of life scores in these students.

Araújo et al. (2014) conducted a study involving nursing academics that shows that from the student's arrival at the university, most of them are young, in the process of change, carrying with them doubts and uncertainties about their adaptation in the academic environment, under strong pressure and stress to match the expectation of relatives. The student will undergo changes in his or her life because he is vulnerable to stress caused

by the university, and the impacts will be addressed according to his psychological maturity, which will reflect moderate levels of stress for one or situations of crisis adaptive for others.

The data show that according to the WHOQOL-BREF questionnaire, all domains showed a good perception of the quality of life. The gender distribution (54.28% female and 45.72% male) was similar to the distribution found by Chazan and Campos (2013) (61% female and 49% male).

Considering the overall result, it was observed a better QoL in the physical domain (14,59) and worse in

the environment (13,96). As in the present study, Claumann et al. (2017) analyzed the quality of life of incoming students in the Physical Education course and presented the physical domain as being the best and the environment is the smallest. Considering that the environmental domain is related to physical security and protection, home environment, financial resources, health, and social care, opportunities to acquire new information and skills, recreation and leisure, physical environment and transportation (ESCAVE et al., 2009 apud ALFREDO, BIONDI, MANNA, 2016, p. 228) [13], this finding may be related to the fact that the students do not work, are dependent on the parents' help, live alone and far from the city of origin, besides having less time to leisure activity due to the academic life that requires more time and dedication.

Although the physical domain presents higher average in the present study as well as in the research of Claumann et al. (2017) [14] this is contrary to what is observed in the daily life of the medical student since they have an extensive study day, few hours of sleep, are hardly involved in physical activities, bad habits of life. As a result, they have less energy and ability to perform the activities of daily living, often needing help from medications. This fact can be observed in a study about the quality of life of undergraduate students in nursing showing that the capacity of concentration, daily energy degree, sleep, capacity for performance in daily and work activities, financial resources and leisure opportunities were negative factors to the participants' quality of life, due to their worse performance (DALMOLIN et al., 2012) [15].

Claumann et al. (2017) [14] observed a better mean in the physical domain (72.7) corroborating with the results of the present article (physical domain with a mean of 14.59). Thus, it seems that the academics in this study are more involved in sports practices and manage to maintain healthy habits of life. As a result, they probably have more energy and ability to perform the activities of daily living, feel less pain and discomfort, and need fewer medications, as well as sleep better (aspects related to the physical domain).

The domain social relations composed of facets personal relationships, social support and sexual activity presented an average of 14.50 in the present study, losing only to the physical domain in the general classification and occupying the highest mean for the female corroborating with study by Raquel, Kuroishi and Mandrá (2016) [16] who, when comparing the QOL of speech-language pathology students in different graduation periods, observed a higher average in this area, being

higher in the fourth period ($G_2 = 73.74$, $SD \pm 18.41$), followed by the second = 72.22 , $SD \pm 13.38$), eighth ($G_4 = 68.91$, $SD \pm 21.67$) and sixth ($G_3 = 64.46$, $SD \pm 20.95$). Serinolli, Oliva, and El-Mafarjeh (2015) [17] also observed higher mean in the domain of the social relation in medical students with no history of medical diagnosis of anxiety, panic or depression.

Moritz et al. (2016) [18] evaluated the quality of life of nursing students of a Brazilian public university and found a good average in the psychological domain (67,7), losing only to social relations (77,2), as opposed to the one found in the present study in which this domain was the second worst. However, as for sex, both this and that study had a better mean score in this domain for males, respectively 15.28 and 69.3, a fact that can be justified by the man compared to the woman presenting several risk behaviors perceiving less the psychological symptoms besides the social requirement that it is always physically and psychologically strong (ARAÚJO et al., 2014) [4].

When analyzing the domains regarding sex, it was observed that women have worse QoL in relation to men in all domains, a result also observed in the study carried out by Luz (2015) [19, 20]. We can observe that the best performance among females is related to the social relation domain (14,30) and the worst performance related to the psychological domain (13,63). Considering males, the best performance is observed in the physical domain (15,56) and the worst in the environment domain (14,03).

Gouveia et al. (2017) [21] points out that factors such as little / no activity for leisure, busy schedule, overload of activities, lack of time for extracurricular activities, conflicting relationship with teachers, competitiveness among students and situations requiring interpersonal relationship are cause of fatigue, fatigue, and anxiety, directly affecting students' QoL. According to Luz (2015) [19] regarding the quality of life, males achieved better results than females in the areas of vitality, social function, emotional performance, and mental health, as well as to overcome in the mental component and quality of general life. This fact may explain why girls present worse indexes in the physical and psychological domains.

The university students are considered a vulnerable group in relation to psychiatric disorders such as depression and anxiety (SOUZA et al., 2018) [22], because during their formation they face several stressful situations such as lack of time and exhaustion due to intense study, with themselves in order to meet the expectations of teachers, colleagues, and society and are constantly affected by insecurity, fatigue, lack of

concentration, sleep disturbance and even depressive symptoms compromising their quality of life. This fact can be observed in the study by Aguiar et al. (2009) [9] in which they evaluated 200 medical students of the University of Ceará on stress and identified that of these, 73.5% considered their academic activities as a source of stress.

Other research carried out by Leão et al. (2018) [23] showed that anxiety and depression were part of daily academic life, with girls ($p = 0.001$) being the most affected, followed by insomnia and sedentary patients. Chazan and Campos (2013) [7] observed lower QoL scores with reported chronic morbidity and reported a predominance of mental and endocrine-metabolic diseases in UERJ academics. Given the above, considering that the prevalence of anxiety and depression among health students is higher than that of students from other areas and from the general population (GALVÃO et al., 2017; LANTYER et al., 2016) [24, 25], it is important to investigate the mental health of this public, since it directly affects the QoL of this population as well as interfere in their training.

Future studies should evaluate factors such as age, schooling, and working or not during the course, having or not having children, whether or not they are in a marriage, which directly interfere with the results of QoL.

IV. CONCLUSION

The QoL of medical students assessed, mean to high scores, although male students presented better values when compared to women in the physical and psychological domains. It is important in future studies to evaluate the motives that favor these results.

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REFERENCES

- [1] PEDROSO B. et al. Cálculo dos escores e estatística descritiva do WHOQOL-bref através do Microsoft Excel. 2010. **Rev Bras Qualidade Vida**, v. 2, n. 1, p. 31-36, 2010. Disponível em: <https://periodicos.utfrpr.edu.br/rbqv/article/view/687>. Acesso em: 22/04/2019.
- [2] FIEDLER, P. T. **Avaliação da qualidade de vida do estudante de medicina e da influência exercida pela formação acadêmica**. 2008. Tese (Doutorado em Medicina Preventiva) - Faculdade de Medicina, Universidade de São Paulo, São Paulo, 2008. Disponível em: <http://www.teses.usp.br/teses/disponiveis/5/5137/tde-10072008-161825/pt-br.php>. Acesso em: 09/03/2019.
- [3] BRASIL, ORGANIZAÇÃO MUNDIAL DE SAÚDE. Promoção da Saúde – Glossário. OMS, Genebra, p. 28, 1998. Disponível em: http://apps.who.int/iris/bitstream/handle/10665/67246/WHO_HPR_HEP_98.1_spa.pdf?sequence=1&isAllowed=y. Acesso em: 24/04/2019.
- [4] ARAUJO, M. A. N. et al. Qualidade de vida de estudantes de enfermagem. **Rev. Rene**. v. 15, n. 6, p. 990-997, 2014. Disponível em: <http://www.periodicos.ufc.br/rene/article/view/3297>. Acesso em: 09/03/2019
- [5] BARALDI, S. et al. Avaliação da qualidade de vida de estudantes de nutrição. **Trab.Educ.Saúde**, v.13 n.2, p.515-531, 2015. Disponível em: <https://www.redalyc.org/pdf/4067/406756980015.pdf>. Acesso em: 09/03/2019
- [6] CARVALHO, M. C. P. et al. Levantamento da situação de saúde mental e uso de ansiolíticos e antidepressivos por acadêmicos do curso de odontologia de uma Universidade do sul de Minas Gerais. **Revista da Universidade Vale do Rio Verde, Três Corações**, v. 15, n. 1, p. 489-496, 2017. Disponível em: <http://periodicos.unincor.br/index.php/revistaunincor/article/view/2772>. Acesso em: 09/03/2019.
- [7] CHAZAN, A. C. S.; CAMPOS, M. R. Qualidade de vida de estudantes de medicina medida pelo WHOQOL-bref - UERJ, 2010. **Rev. bras. educ. med**, v. 37, n. 3, p. 376-384, 2013. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S00-55022013000300010. Acesso em: 09/03/2019.
- [8] FIGUEIREDO, A. M de et al. Percepções dos estudantes de medicina da UFOP sobre sua qualidade de vida. **Revista Brasileira de Educação Médica**, v. 38, p. 435-443, 2014. Disponível em: <http://www.repositorio.ufop.br/handle/123456789/6063>. Acesso em: 08/03/2019.
- [9] AGUIAR, S. M. et al. Prevalência de sintomas de estresse nos estudantes de medicina. **J. bras. psiquiatr.**, v. 58, n. 1, p. 34-38, 2009. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0047-20852009000100005&lng=en&nrm=iso. Acesso em: 09/03/2019.
- [10] BAMPI, L. N. S. et al. Qualidade de vida de estudantes de medicina da Universidade de Brasília. **Rev. bras. educ. med.**, v. 37, n. 2, p. 217-225, 2013. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0100-55022013000200009&lng=en&nrm=iso. Acesso em: 09/03/2019.
- [11] FEODRIPPE, A. L. O; BRANDAO, M. C. F.; VALENTE, T. C. O. Qualidade de vida de estudantes de Medicina: uma revisão. **Rev. bras. educ. med.**, v. 37, n. 3, p. 418-428, 2013. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0100-55022013000300014&lng=en&nrm=iso. Acesso em: 09/03/2019.
- [12] CUNHA, D. H. F. et al. Percepção da qualidade de vida e fatores associados aos escores de qualidade de vida de alunos de uma escola de medicina. **J. bras. psiquiatr.**, v.

- 66, n. 4, p. 189-196, 2017. Disponível em http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0047-20852017000400189&lng=pt&nrm=iso. Acesso em: 09/03/2019.
- [13] ALFREDO, P. P.; BIONDI, J. C. L.; MANNA, V. Avaliação da qualidade de vida e estresse em acadêmicos do curso de Fisioterapia. **J Health Sci Inst.**, v. 34, n. 4, p. 224-30, 2016. Disponível em: https://www.unip.br/presencial/comunicacao/publicacoes/ics/edicoes/2016/04_out-dez/V34_n4_2016_p224a230.pdf. Acesso em: 24/04/2019.
- [14] CLAUMANN, G. S. Qualidade de vida em acadêmicos ingressantes em cursos de educação física. **J. Phys. Educ.**, v. 28, n. 1, p. 1-11, 2017. Acesso em: <http://www.scielo.br/pdf/jpe/v28/2448-2455-jpe-28-e2824.pdf>. Disponível em: 24/04/2019.
- DALMOLIN, G. L. et al. Implicações do sofrimento moral para os (as) enfermeiros (as) e aproximações com o Burnout. **Texto e contexto enfermagem**, v. 21, n. 1, p. 200-2-8, jan/mar, 2012. Disponível em: <http://www.scielo.br/pdf/tce/v21n1/a23v21n1.pdf>. Acesso em: 01/05/2019.
- [15] RAQUEL, A. C. S.; KUROIISHI, R. C. S.; MANDRÁ, P. P. Qualidade de vida de estudantes de fonoaudiologia. **Revista Cefac**, v. 18, n. 5, p. 1133-1140, Set-Out., 2016. Disponível em: http://www.scielo.br/scielo.php?pid=S1516-18462016000501133&script=sci_abstract&lng=pt. Acesso em: 01/05/2019.
- [16] SERINOLLI, M. I.; OLIVA, M. P. M.; EL-MAFARJEH, E. Antecedentes de ansiedade, síndrome do pânico ou depressão e análise do impacto na qualidade de vida em estudantes de medicina. **Revista de gestão em sistemas de saúde**, v. 4, n. 2, p. 113-126, julho/dezembro, 2015. Disponível em: <http://www.revistargss.org.br/ojs/index.php/rgss/article/view/205>. Acesso em: 01/05/2019.
- [17] MORITZ, A. R. et al. Qualidade de vida de estudantes de enfermagem de uma universidade pública brasileira. **Invest. Educ. enferm.**, v. 34, n. 3, agosto, 2016. Disponível em: http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0120-53072016000300564&lng=en&nrm=iso&tlng=pt. Acesso em: 01/05/2019.
- [18] LUZ, T. D. D. **Análise da atividade física e qualidade de vida em estudantes de Ciências do Desporto**. 2015. 79 p. Dissertação (Mestrado em Atividade Física em Contexto escolar) - Faculdade de Ciências do Desporto e Educação Física, Universidade de Coimbra, Coimbra. Disponível em: <https://estudogeral.sib.uc.pt/handle/10316/30373>. Acesso em: 24/04/2019.
- [19] GOUVEIA, M. T. de O et al. Quality of life and welfare of nursing university students: an integrative review. **Rev Enferm UFPI**, v. 6, n. 3, p. 72-80, Jul-sep 2017. Disponível em: <http://www.ojs.ufpi.br/index.php/reufpi/article/view/6074/pdf> Acesso em: 28/04/2019.
- [20] SOUZA, J. F. et al. Depressão e ansiedade no ambiente acadêmico: uma revisão integrativa. In: CONGRESSO BRASILEIRO DE CIÊNCIAS DA SAÚDE, 3., 2018, Campina Grande. **Anais**. Campina Grande: Editora realize, 2018. Disponível em: <https://editorarealize.com.br/revistas/conbracis/resumo.php?idtrabalho=847>. Acesso em: 01/05/2019.
- [21] LEAO, A. M et al. Prevalência e Fatores Associados à Depressão e Ansiedade entre Estudantes Universitários da Área da Saúde de um Grande Centro Urbano do Nordeste do Brasil. **Revista brasileira de educação médica**, v. 42, n. 4, p. 55-65, 2018. Disponível em: <http://www.scielo.br/pdf/rbem/v42n4/1981-5271-rbem-42-4-0055.pdf>. Acesso em: 28/04/2019.
- [22] GALVÃO, A. et al. Ansiedade, stress e depressão relacionados com perturbações do sono-vigília e consumo de álcool. **Revista Portuguesa de Enfermagem de Saúde Mental**, p. 8-12, 2017. Edição especial. Disponível em: http://www.scielo.mec.pt/scielo.php?script=sci_abstract&pid=S1647-21602017000200002&lng=pt&nrm=iso. Acesso em: 01/05/2019.
- [23] LANTYER A. S. et al. Ansiedade e Qualidade de Vida entre Estudantes Universitários Ingressantes: Avaliação e Intervenção. **Faculdade de Ciências do Desporto e Educação Física, Universidade de Coimbra**, v. 18, n. 2, p. 4-19, 2016. Disponível em: <http://www.usp.br/rbtcc/index.php/RBTCC/article/view/880>. Acesso em: 01/05/2019.

Physicalchemical Characteristics of Honey from Apicultural Production in the Paraná River Islands in Guaira-PR/ Brazil

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Abstract— The aim of this study was to perform physicochemical analyzes of honey in terms of moisture content, pH, hydroximetifurfural (HMF), acidity, diastasis, sugars and sucrose. The reason of comparing the results obtained in the physicalchemical analysis of honey according to the established standards for honey of *Apis mellifera*, in accordance with the requirements of the national or international regulatory agencies, to verify the quality of honey produced. The physicalchemical analysis included among the maturity indicators of honey: moisture, pH, acidity and HMF. The research was done with data collection to evaluate the main honey producers of the Paraná River Islands with delimitation comprising the population of the Ayrton Senna da Silva bridge to the village called Porto Morumbi (Mato Grosso do Sul State, Brazil). The volume of higher honey production was analyzed, having as sample 06 beekeepers, where their coordinates were observed identifying the points obtained through the (Global Positioning System) GPS device. The physicochemical analysis of the minimum, maximum and average showed that the humidity is was least 18:95; maximum 23:70 and average 21:60, which according to the normartive n° 11 of 2000, are above the allowed.

Keywords— Averages, Beekeepers, Honey, Honey maturity indicators.

I. INTRODUCTION

Brazil has a great beekeeping potential, due to the fact that its flora is very diversified, due to its territorial extension and climatic variability, which makes it possible to produce honey all year round. This aspect already sets it apart from other countries that normally harvest honey once a year. However, despite this advantage, there is a great variation in the characteristics of the honeys produced [1].

Bees breeding currently represents an important agricultural activity in Brazil, representing work and income for many families of small and medium rural producers. Honey is the most important of honey bee products, being the main objective of the Brazilian beekeeping [2].

In Brazil, the main producers of honey are small farmers where beekeeping is added to other economic activities and the main producing region is the South Region, with 49% of Brazilian production. Rio Grande do

Sul State is the largest national producer with 20%, Paraná State with 16.2% and Santa Catarina with 12.9% [3].

According to the Brazilian Institute of Geography and Statistics [IBGE], in 2012 Brazilian honey production generated R\$ 40 million and grew 24% in the last six years. By volume were approximately 33,931 tons [4].

Because of their great diversity in their composition, studies aimed at the characterization of the honeys produced are of extreme importance for the creation of quality standards according to plant, soil and climatic factors. regions in which they are produced, subsidizing their quality improvement and giving product guarantees to the consumer by controlling possible fraud [1].

The qualitative characterization of honeys, or of any food, is essential as part of the valorization strategies of the product, since it confers a regional identity, besides adding value to it [5].

It is known that the characterization and standardization are entirely linked to the quality of a product. In this way, the concern with the maintenance of the quality of the honey produced in Brazil is increasing, as well as the knowledge of the variation of the characteristics that are used as quality requirements. Therefore, it is of great importance to study and quantify the behavior of parameters that indicate quality in all stages of the production flowchart, thus obtaining information where it is possible through them to decrease the chances of deterioration and thus, increase the shelf life of this product [6].

There is great interest in guaranteeing the quality of honey and the various apicultural products, and the physicalchemical characterization serves as a tool for this control, where through this one can guarantee the standardization of honeys marketed and offered to consumers, even consumed in nature or when they are used as ingredients in new products [7],[8],[9].

In this sense, the region under study presents excellent conditions for beekeeping, considering that the climate is favorable and also because of the richness of flowers in its vegetation. The objective of this study was to perform physicalchemical analyzes of honey considering the moisture contents, pH, HMF, acidity, diastasis, sugars and sucrose.

II. MATERIAL AND METHODS

The research was done through data collection with a survey of information to evaluate the main honey producers of the Paraná River Islands, with a delimitation comprising the population of the Ayrton Senna da Silva Bridge to the village of Porto Morumbi. The volume of higher honey production was analyzed, having as sample 6 beekeepers, where their coordinates were observed identifying the points obtained through the GPS device.

The target region of the study is of subtropical climate, with mild temperatures and has small part in the tropical climate region. (Köppen classification).

2.1 Research Design

The study encompasses a completely randomized experimental design, totaling 31 samples of honey (Figure 1). The “R” statistical and programming environment version 3.0.2 (R Foundation, Vienna, Austria) was used.

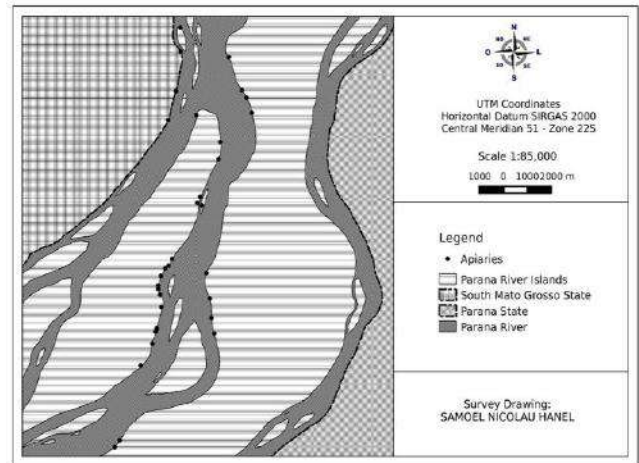


Fig. 1: Georeferenced map of location of apiaries, 2016, Paraná River.

2.2 Collection of Samples

The 31 honey collected samples correspond to the 2015 harvest and were purchased directly from beekeeper's apiaries in 350 ml bottles sterilized, wrapped in a plastic bag for first-time food. The collection period was given on 17-19 April 2015.

The samples were sent to the Laboratory of Physicalchemical Analysis of the Insecta research group, belonging to the Federal University of the Recôncavo da Bahia (UFRB).

The physicochemical analyzes included the indicators: reducing sugars, moisture, sucrose, acidity, diastase activity, HMF and pH. All analyzes were performed in duplicate, following the methods recommended by Brazilian legislation (Brasil, 2000). The procedures used are in accordance with the methodology of the Association of Official Analytical Chemists [10].

III. RESULTS AND DISCUSSIONS

The results of the study of the physicalchemical characteristics of the 31 samples of bee honeys of the Paraná River micro-region presented indexes with higher moisture content 25g/100g; for sugars were all the results of the analyzes in accordance with the Normative, being of 65g/100g; for sucrose, the maximum is 6g/100g and with the analyzes it was verified that only 06 samples exceeded the value, as determined in the regulations. As for the acidity indexes, it was verified that all the analyzed analyzes were within the legal parameters of Normative Instruction n° 11; and on HMF, in the analyzes only one sample exceeded the permitted one, being 119.91 mg/kg; and the allowed maximum of 60 mg/kg.

Regarding the analyzes of the diastase activity, it was verified that only one analysis was below the allowed parameters being 7.90 mg/kg and the allowed value must be at least 8 mg/kg. As far as pH is concerned, all analyzes were in accordance with the Honey Production Regulation. These values are shown in Tables 1, 2 below.

Table 1. Basic statistical data of samples of honey harvested in and around Perucia Island in the Paraná River, from April 17 to 19, 2015.

	Average	Standard Deviation	If (mean) Standard error of the mean	Percentage 50%	Percentage 95%
Moisture	21,60	1,08	0,19	21,75	22,80
PH value	3,68	0,15	0,03	3,67	3,97
Acidity	11,80	1,31	0,24	11,85	14,70
Hydroxymetilfurfural	22,37	23,81	4,27	15,27	66,73
Dwell	18,66	6,12	1,10	17,71	27,33
Sugars	73,37	2,68	0,48	72,61	77,81
Sucrose	3,31	1,79	0,32	3,20	6,03

Table 2. Basic Statistical data of samples of honey harvested in and around Perucia Island in the Paraná River, from April 17 to 19, 2015.

	Moisture	PH	Acidity	HFM	Diastasis	Sugars	Sucrose
Minimum	18.95	3.410	8.65	2.69	8.00	68.90	0.610
1 ^o Quartile	21.35	3.580	11.16	11.82	13.99	71.28	1.885
Medium	21.75	3.670	11.85	15.27	17.71	72.61	3.200
Average	21.60	3.683	11.80	22.37	18.66	73.37	3.310
3 ^o Quartile	22.23	3.735	12.32	23.39	22.23	75.19	4.545
Maximum	23.70	4.030	14.99	119.91	35.43	80.12	7.880

The moisture content is an important characteristic to determine the quality of the honey, not lower than 16.8% and not more than 20%, according to Instruction n° 11 of October 20, 2000, which establishes as maximum value of moisture 20g per 100g of honey, this parameter being considered indicative of maturity. In honey composition, water constitutes the second component in quantity, depending on the climate, floral origin and harvest before complete dehydration [11].

According to data from the physicochemical analysis of the minimum, maximum and average averages, it was found that the humidity is at least 18:95; maximum 23:70 and average 21:60, which according to Normative No. 11 of 2000, are above permitted. The result is justified because, in the majority of cases, the samples were with the honeycomb in the process of maturing the honey, and in this stage the high moisture content in these samples is justified. Moisture is the second highest percentage component in honey. With regard to the moisture content of honey, it was verified of the 31 samples, only four were within the standards of Normative Instruction No. 11 of October 20, 2000. The indices with the highest moisture content were 25g/100g.

The content of water has a direct influence on the viscosity, color, specific gravity, maturity, crystallization, conservation and palatability [12]. The difference in humidity may be due to the bee's handling in the honey,

since, in general, the bee *Apis Opercula* (closes) the honey when it presents around 17% to 18% of humidity, which operates honey jar with humidity variations around 24% [8]. Another factor is the osmophilic microorganisms present in the bodies of bees, nectar, soil and areas of extraction and storage of honey, and when present in honey multiply with increasing humidity, favoring the fermentation process [13].

In general, honey can compromise honey humidity are the location of apiaries (near the water source and or in very humid environments), harvesting honey ahead of time ("green" honey), or on cloudy, rainy days, the use of permeable and semipermeable packages that allow the exchange of moisture between the honey and the environment (Pereira et al., 2003). Mature honey generally has a moisture content of 18%. This is important, because the moisture content has an influence on other characteristics, such as: viscosity, weight, conservation, flavor and crystallization [14].

As for the coloring of the honey, it involves the characteristics of the origin of the flower, being able to be light, red, gold or dark. Depending on the type of coloring, honey has a difference in flavor and the aroma manifests changes, preserving the nutritive value. The darker the honey, the more minerals it has, but the lower the commercial value, because the light color is more accepted in the world market, being sold at a higher price. The different botanical origins of honey were identified with a predominance of light to dark color [15].

Of the 31 analyzed samples that had different values from those established by Brazilian legislation, HMF was above the maximum accepted values, even reaching 119.91 mg/kg, with a maximum of 60 mg/kg being allowed. For sugars, all the results of the analyzes were in accordance with the Normative, being of 65g/100g; for sucrose, the maximum is 6g/100g; and with the analyzes it was verified that only 6 samples exceeded this value, as determined by the Normative.

As for the acidity indexes, it was verified that all the analyzes performed are within the legal parameters of Normative Instruction n° 11. In the diastase activity, only one sample presented a slight change in the result verified in its physicalchemical characteristics. In the first laboratory test the value found was 7.90mg/kg, which in turn, was below the limit allowed by the Legislation, which is 8.00mg/kg. The second analysis performed in the laboratory test of this sample, resulted in 8.10mg/kg that in turn was within the standards required by the Legislation. If you consider this small variation, you can

say that all the samples are within the standard required by the Legislation.

IV. CONCLUSION

With the basic statistical data of the samples of the honeys of Perucia Island and the surroundings of the Paraná River, harvested in the periods of April 17 to 19, 2015, it was concluded that the results of the physicalchemical analyzes, the comb was in the process of maturing and at this stage the high moisture content in these samples is justified.

The pH, as well as the acidity, in all samples, where the analyzes were carried out in duplicate, presented values within the parameters of Normative Instruction No. 11 of October 20, 2000. The results of the HMF, after analysis of the samples in duplicate, showed that only one sample in question went from the maximum allowed by the Normative Instruction. The maximum permitted value is 60mg/kg and the result of this sample was 119.91mg/kg. This result is also justified, because this sample suffered the interference of contact with the sun, causing a fermentation process to develop.

As regards the reducing sugars data, all samples are in compliance with the legislation, both for the first time and also for their duplicate analyzes. In the whole process of the physicalchemical analysis, including the duplicate process, it was found that only 6 results were above the allowed by the legislation, which is 6g/100g, giving us a parameter satisfactory result from legislation.

In this sense, it was concluded that after the physicalchemical analysis of the samples of the honeys harvested in the Paraná River Islands and that are resized within the region of the present study, it was possible to obtain an excellent parameter of honey quality, since it is according to Normative Instruction No. 11 of October 20, 2000 (Brasil, 2000).

In other studies, with the product, it is suggested to develop a line of research aimed at the certification of an organic product, which would add in a lot the commercial value of the same, for a market in rapid expansion.

REFERENCES

- [1] MARCHINI, L.C.; SOUZA, B.A. Composição físico-química, qualidade e diversidade dos méis brasileiros de abelhas africanizadas. (2006). In: Congresso Brasileiro de Apicultura, Aracajú, Brasil.
- [2] OLINTO, F. A. (2014) Comportamento higiênico e identificação de patógenos em colmeias de *Apis mellifera* L. africanizadas no sertão paraibano. (Tese de doutorado). Universidade Federal de Campina Grande, Campina Grande.
- [3] BOFF, T.; ROSA, C. S.; SANTOS, R. C. V. (2008). Qualidade Físico-química e microbiológica de méis comercializados nos principais supermercados de Santa Maria, RS. *Higiene Alimentar*, 22(162), 57- 61.
- [4] BRASIL, Instituto Brasileiro de Geografia e Estatística – IBGE, Produção da pecuária municipal. Rio de Janeiro, RJ. ISSN 0101-4234 (meio impresso), v. 43, p.1-49, 2015.
- [5] BENDINI, J.N.; SOUZA, D.C. (2008). Caracterização físico-química do mel de abelhas proveniente da florada do cajueiro. *Ciência Rural*, 38 (2), 565-567. <http://dx.doi.org/10.1590/S0103-84782008000200047>.
- [6] MOURA, S. G. (2010). Boas práticas apícolas e a qualidade do mel de abelhas *Apis mellifera* Linnaeus, 1758. 2010. (Tese de doutorado). Universidade Federal do Piauí, Teresina.
- [7] GOIS, G. C.; LIMA, C. A. B.; SILVA, L. T.; RODRIGUES, A. E. (2013). Composição do mel de *Apis mellifera*: requisitos de qualidade. *Acta Veterinaria Brasilica*, 7 (2), 137-147, 2013. <https://doi.org/10.21708/avb.2013.7.2.3009>.
- [8] MENDES, C. G.; SILVA, J. B. A.; MESQUITA, L. X.; MARACAJÁ, P. B. (2009). As análises de mel: revisão. *Caatinga*, 22 (2), 07-14. <https://periodicos.ufersa.edu.br/index.php/caatinga/article/view/789/633>.
- [9] SANTOS, D. C.; OLIVEIRA, E. N. A.; MARTINS, J. M.; ALBUQUERQUE, E. M. B. (2011). Qualidade físico-química e microbiológica do mel de *Apis mellifera* comercializado na cidade de Russas, CE. *Tecnologia e Ciência Agropecuária*, 5 (1), 41-45. http://revistatca.pb.gov.br/edicoes/volume-05-2011/volume-5-numero-1-marco-2011/tca08_qualidade_mel.pdf.
- [10] AOAC. Association Of Analytical Chemists. (1998). Official Methods of analysis. 15th. Supl 2.
- [11] BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. (2000). Instrução Normativa no 11, de 20 de outubro de 2000. Aprova o Regulamento Técnico de Identidade e Qualidade do Mel. *Diário Oficial da União*.
- [12] PEREIRA, F. M.; VILELA, S. L. O. (2003). Estudo da cadeia produtiva do mel do estado de Alagoas. Maceió: SEBRAE/AL, 49 p.
- [13] WHITE, J. W. Jr. Honey. (1978). *Advances in Food Research*, v. 22, p. 287-374.
- [14] AZEREDO, M. A. A.; AZEREDO, L. da C.; DAMASCENO, J. G. (1999). Características físico-químicas dos méis do município de São Fidélis-RJ. *Food Science and Technology*, 19 (1), 3-7. <http://dx.doi.org/10.1590/S0101-20611999000100003>.
- [15] VENTURINI, K. S. SARCINELLI, M. F. SILVA, L. C. (2007). Características do mel. (Trabalho de conclusão de curso) Universidade Federal do Espírito Santo, Vitória. <https://monografias.ufma.br/.../Monografia%20Jam%20da%20pdf>.

Ergonomic Risk Reduction with Automation of the Motorcycle Rear Lantern Mounting Process: Case Study in the PIM – AMAZONAS-BRAZIL

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Abstract— The present work deals with the use of pneumatic devices, applied in productive processes to improve an ergonomic problem. An easy-to-use automation system was implemented and evaluated for the assembly process of the motorcycle rear lantern product, since it was in high levels of absenteeism and rejection due to ergonomic effort. The case study was carried out in a motorcycle company, through the collection of data regarding the operation on the line and technical report records containing performance indicators. The results obtained were the reduction of ergonomic risks, thus guaranteeing safety standards, quality and ergonomics. The process of continuous improvement and of great relevance for both the company and the employees involved.

Keywords— Automation, Pneumatics, Ergonomics and Quality.

I. INTRODUCTION

Automation is a fundamental element that enables companies to meet the market demands. With the purpose of improving time and resources, providing higher quality and productivity for the most diverse processes in which it remains linked, in addition to promoting greater safety and quality of life for its employees [1]. Automation means the organized dynamics of automatisms, that is, their associations in an optimized way and directed towards the attainment of the objectives of the human program [2].

The search for the automation in the industrial sector manifests when the company understands the greater need to be productive, pretending to the greater speed, reliability, versatility and production flow [3]. The involvement of compliance with specific methods, software and tools establishing the machine or industrial process, has several objectives, stressing the improvement of efficiency through optimization of resources, repetitiveness in execution, reduction of time and process costs.

The aim of this work was ergonomic risk reduction with automation of the motorcycle rear lantern mounting process, for this purpose it had specific objectives: to raise variables of the manufacture process; Establish the mechanism that leads to the creation of the device in

order to automate the assembly process in order to reduce ergonomic risks; Aim solutions for the mechanism in the motorcycle rear lantern mounting process.

II. LITERATURE SURVEY

2.1 PNEUMATIC, ELETROPNEUMATIC AND INDUSTRIAL AUTOMATION

Pneumatics refers to the use of gases, which gives the automation process a great possibility of functionality for machines and equipment. The many features offered by it make it paramount for automation methods.

According to [2], "Pneumatic comes from the Greek root PNEUMA, which means breath, wind, blow. Therefore, pneumatics is conceptualized as being the matter that deals with the movements and phenomena of gases."

For [4], electropneumatic is the branch of pneumatics that starts using DC or AC electrical energy as a source of energy for the activation of directional valves, thus composing the so-called electrovalves and proportional valves, also energizing magnetic positioning sensors, pressure switches, micro-switches, etc.

Automation can be established as the technology through a process or procedure is obtained without human assistance. Despite being done in many areas, automation is immediately added to the production industries. In that

circumstance, the term was originally developed in 1946 by a Ford Motor Company engineer to reproduce the variety of automatic transfer devices and power mechanisms that had been installed in the company's production plants.

Automation is a definition and an aggregation of techniques by means of which active systems prepared to act with optimum efficiency are incorporated by the use of information acquired from the environment in which they act. Regarding the information, the system calculates the most favorable corrective action for the execution of the action and this is a closed-loop pattern, known as feedback systems [6].

2.2 ERGONOMICS

Ergonomics involves a set of knowledge where it is based on responses to different demands. The purpose of ergonomics is to help meet human needs in the workplace, integrating the promotion of health and well-being. In a thorough and methodological investigation of work situations, ergonomics intends to reorganize them in such a way as to exclude sources of loss, that is, to abolish notable aggressors that may lead to partial or total impairment of any vital function, in short, medium or long term [7].

Ergonomics is the set of scientific knowledge relating to the human being and necessary for the design of tools, machines and devices that can be used with maximum comfort, safety and efficiency. " [8]. A software is presented by [9], to assist in the application of ergonomic tools.

2.3 QUALITY

From the point of view of production, quality is associated with the design and production of a product, in order to satisfy the needs of the customer and, from the point of view of the customer, quality is associated with the value and utility that it recognized on the product.

The principle underlying this view of total quality is that in order to achieve real effectiveness, control must begin with product design and only end when a product has reached the hands of a customer who is satisfied [10].

For Marshall [11], "quality is a term that has become part of the jargon of organizations, regardless of their field of activity and scope of action, public or private."

In order for a company to always guarantee quality in its products, investments in machines and equipment are necessary, because through them it is possible to increase

the level of reliability, guarantee higher quality and avoid reworking due to production failures.

"Quality is the suitability for use" [12].

"Quality is the degree of adjustment of a product to the demand it intends to satisfy" [13].

Quality management is a good management process. In any area. The involvement of the article in the expression quality management modifies it into something specific. Quality management is, however, the management of something well indicated, called quality. Quality management is something general; Quality management is a technical area of the organization [14].

Quality tools are tools that facilitate the execution of the method, dealing with information, its collection and processing. By analyzing the results and determining their causes, it is possible to identify control and improvement actions and their priority, assisting in decision-making and problem-solving processes.

III. MATERIALS AND METHODS

An analysis was carried out in one of the processes developed in a motorcycle assembly company, where the sector indicators of absenteeism, quality and productivity were studied. It was highlighted the process of assembling the lock of the right and left rear signs, in which it presented high index of absenteeism, which was causing high defect rates, due to incorrect assembly, besides the difficulty of the collaborator to perform the assembly, bringing risks to his health.

Given the difficulties, an easy-to-install device with the best cost-benefit for the company was developed. This device used a simplified pneumatic system whose function reduces the impact of force caused by the process collaborator, promoting agility and efficiency in execution, reducing quality problems and increasing productivity and reducing ergonomic risks.

IV. ANALYSIS OF RESULTS

4.1 HISTORY OF THE PROBLEM

The indicators for the definition of the work station in which improvement is needed were following the quality, production, personnel and safety data.

Historical indicators during the period of the 12 months of 2018,

Regarding the item quality, rejection goal 0.011, real 0.010, positive difference of 0.001; goal zero locks, real 1 blocking and production suspension.

Regarding the item Production, target efficiency 70%, real 65.57%, negative difference of 4.43%; line stop 24, real 28, negative difference of 4 stops in the assembly of components.

Regarding the personal item, absenteeism goal 2.1%, real 6.8%, negative difference 4.7% of absenteeism in the assembly of components in the period; accidents zero goal, zero real accidents registered in the component assembly sector.

With the analysis of these indicators, a GUT quality tool was used that uses the severity, urgency and tendency to define the area to be chosen for the improvement theme. One of the alarming items to be studied was the quality, but there was an improvement work being implemented to reduce this indicator with that, the urgency factor was reduced, thus highlighting the personal item by the amount of absenteeism with 58%, much higher of the stipulated sectorial target, of these absences, the medical licenses that were responsible for 86% of this item stand out. Collecting the data in the item medical licenses was possible to indicate the main reasons for these licenses that were ergonomic problems, which corresponded to 38% of the total medical licenses.

Stratifying the ergonomic problems in the works of the Assembly of Components sector, we obtained prominence for the assembly of the rear markers with 43% of the total, which justifies the reason for choosing the theme of this project.

It is also highlighted in the indicator of quality problems in the sector that is responsible for approximately 33% of the quality problems in the assembly of components.

4.2 ANALYSIS OF THE MECHANICAL CHARACTERISTICS OF THE COMPONENTS

4.2.1 Components Analysis

The assembly of the flags involves three pieces to be studied in order to find the cause of the occurrence of the ergonomic problems that occurred in this work station. The rear stop (figure 1a) is the item where the Right and Left Rear Signals are attached (figure 1b). The Latch Lock (figure 1c) is intended to secure the rear flags to the correct position on the rear bumper.

With the availability of the parts to be studied, item analysis and analysis were performed to determine if the hardness (figure 4) of the material was as specified in drawing, in order to certify that the parts were within the parameters required for their manufacture.

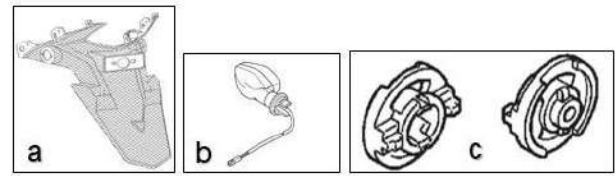


Fig. 1: assembly components

An analysis was performed and a report was issued on the measurement of the hardness of the components, attesting that the item is as specified in drawing.

4.2.2 Component Assembly Analysis

With the confirmation that the parts were as specified, an assembly test was performed to verify the conditions and interferences in the items studied. Manual assembly was carried out according to the conditions of the production process (figure 2). and with the dimensioning data of the parts of the assembly the interference of 4 mm between the flag stem and the lock was verified (figure 3).



Fig. 2: manual assembly

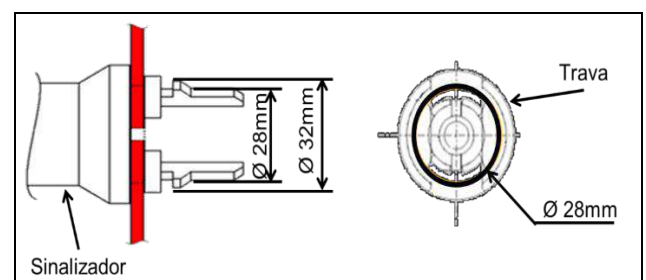


Fig. 3: Interference Illustration

With the aid of the digital dynamometer of the brand Instrutemp, model ITFG-5005 with capacity of measurement up to 150 kg, the force required for the assembly of the flag in 10 samples was verified and concluded that the greatest force applied was of 16,5 kgf.

The effort to mount the latch lock far beyond that allowed by the ergonomic analysis tools. The maximum

allowed for the application of manual force in productive processes is 0,6 kgf.

4.3 RESULTS CONCERNING THE DEVELOPMENT OF THE DEVICE PROJECT

4.3.1 Pneumatic circuit design

4.3.1.1 Pneumatic Actuator Specification

According to the results on the mechanical characteristics of the components for the execution of the locking assembly it is necessary to apply a force between 9.3 kgf and 16.5 kgf. For the application of this force calculation is necessary for the definition of this Pneumatic Actuator, this calculation is defined by the Force (F) in kgf, equal to the Compressed Air Pressure (p) in bar, multiplied by the area of the cylinder piston in cm² (A) according to equation 1.

$$F = p \times A \quad \text{EQ (01)}$$

With the application of data in equation 1 we verified that to reach the force of 16.5 kgf a pneumatic actuator with piston of diameter 18.6 mm is required. After defining the piston diameter it is necessary to specify the stroke length. With the analysis of the paralama dimension, a cylinder with a stroke of 100 mm was specified.

4.3.1.2 Elaboration of the Pneumatic Scheme

After defining the actuator to be used, for its correct operation it is necessary to draw up the pneumatic scheme to determine the items to be used in the system.

FluidSIM software distributed by Festo was used to create pneumatic and electrical systems. This software enables the drawing of electro-pneumatic diagrams in a simple and fast way, besides demonstrating the realistic simulation of the drawing based on the physical models of the components, making it an excellent tool for the creation of these circuits (figure 4).

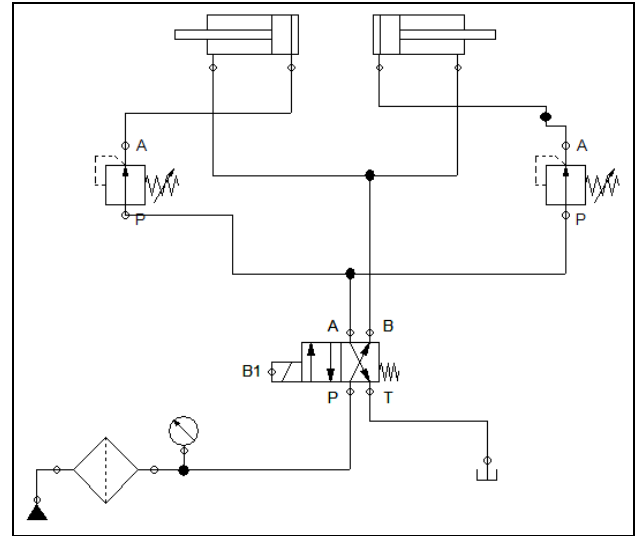


Fig. 4: Simplified Pneumatic Circuit

Figure 4 shows the simplified pneumatic design of the design, where a valve actuates two pneumatic actuators for the execution of the flag latch assembly.

4.3.2 Electrical Circuit project

With the creation of the pneumatic circuit, it has enough information to create the electrical system of the project. In order to comply with the safety regulations of NR10 and NR 12, it is necessary to install photocells and bimanual pushbuttons, thus complying with safety regulations. The electrical circuit was also created using FluidSIM software (Figure 5).

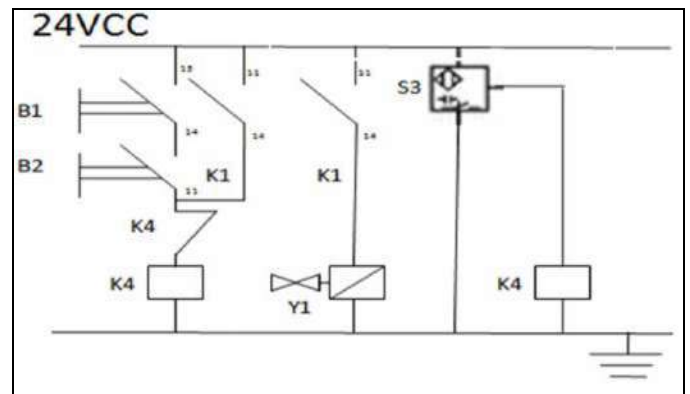


Fig.5: Simplified Electrical Circuit

4.3.3 Mechanical Design project

Defined cylinder to be used in the preparation of the project was drawn the design of the mechanical structure of the device that aims to ensure the fixation of the assembly for its assembly. For the creation of this design was used Solid Edge software distributed by Siemens,

CAD software that began its creation in the 90's and presents a simple and practical way to create projects.

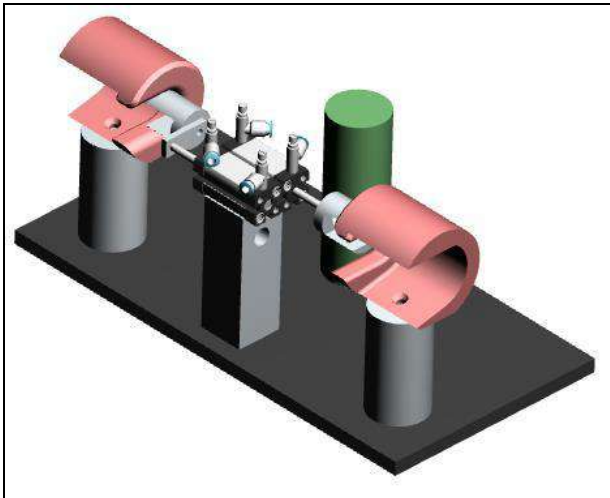


Fig.6: Mounting device

Figure 6 shows the 3D design of the assembly device.

4.4 RESULTS REGARDING THE MANUFACTURE OF THE DEVICE

For the construction of the device were used machines and tools of machining, materials available in the sector Technical Group of the company Alfa. An aluminum plate with the thickness 12mm and dimensions 400mm x 200mm was used as the base of the device and using a drill of column and drills was made drilling according to the drawing of the item. For the manufacture of the supports, Nylon and Polyurethane billets were used as feedstock, and the machining operations were performed using Lathe and Milling Machine.

For the fixation of the items was used allen screws with cylindrical head with metric thread \varnothing 6mm, m6, and metric thread \varnothing 5mm, m5. As results we have the device (figure 7). After the device was built and the pneumatic actuators were installed a simple system was set up for testing the device. Once the device has been tested, the complete equipment has been assembled.

In order to comply with the Brazilian safety standard on machinery and equipment NR12, Annex 8 Item 2.1, the safety systems in the acceptable pressing or working zones must be the enclosure of the pressing zone.

To conform to this standard, the structure of a deactivated and adjusted equipment for the use of the device was reused.

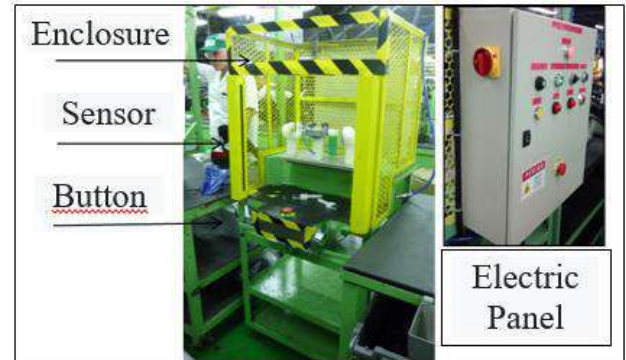


Fig.7: Final device

After the implantation of the device is expected to eliminate the ergonomic problems related to the assembly process, transferring the application of the necessary force of the locking to the pneumatic actuator, thus reducing the absenteeism index of the component assembly sector.

With the implantation of the device is also expected to reduce 33% of quality problems related to the assembly process.

V. CONCLUSION

The implementation of equipment and device for ergonomic risk reduction are of great importance, as well as reducing risks to the health of the worker, reduces costs and increases production through the improvement of the process, through increased efficiency and reduction of human fatigue.

This project allowed a broad knowledge in the area of project development, with the studies carried out, in the classroom, in the study place and in the bibliographic reference, attributing quality to the student for the job market. Through it also was obtained experience in the productive processes, providing better perception for the resolution of problems related to the engineering area. Although this work was based on a negative point of production, there was no problem for the data collection, nor in the development of the project. The positive aspects were the availability of the material, the tools and software used, and the analysis of the jobs.

The project of developing a pneumatic device based on a case study of ergonomic methods in productive processes, with the aid of bibliographical references, established the elaboration and implementation of an efficient and effective project. The objectives of this study were duly achieved.

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REFERENCES

- [1] BARBEDO, Nancy Del Ducca. Análise das Interações das Variáveis no Processo GMAW Duplo Arame para avaliação da qualidade dos Cordões de Solda. 2017.
- [2] FIALHO, Arivelto Bustamante. Automação pneumática– Projetos, dimensionamento e análise de circuitos. Editora Saraiva, 2018.
- [3] MARQUES, Jean Liecheski et al. PROPOSTA DE UMA BANCADA DE BAIXO CUSTO PARA O ENSINO DE AUTOMAÇÃO INDUSTRIAL DE ACORDO COM AS NORMAS DE SEGURANÇA. Revista de Ensino de Engenharia, v. 36, n. 2, 2018.
- [4] BONACORSO, Nelso Gauze; NOLL, Valdir. Automação eletropneumática. Saraiva Educação SA, 2000.
- [5] GROOVER, Mikell P. Automação industrial e sistemas de manufatura. Pearson Education do Brasil, 2011.
- [6] DA SILVEIRA, Paulo Rogério; DOS SANTOS, Winderson Eugenio. Automação e controle discreto. Érica, 2004.
- [7] ALEXANDRE, Neusa Maria Costa. Ergonomia e as atividades ocupacionais da equipe de enfermagem. Revista da Escola de Enfermagem da USP, v. 32, n. 1, p. 84-90, 1998.
- [8] WISNER, Alain. Por dentro do trabalho: ergonomia: método & técnica. Ftd, 1987.
- [9] CYBIS, Walter; BETIOL, Adriana Holtz; FAUST, Richard. Ergonomia e usabilidade: conhecimentos, métodos e aplicações. Novatec editora, 2017.
- [10] FEIGENBAUM, Armand Vallin. Controle da qualidade total. Makron Books, 1994.
- [11] MARSHALL JUNIOR, Isnard et al. Gestão da qualidade e processos. Rio de Janeiro: Fgv, 2012.
- [12] JURAN, Joseph M. Controle da qualidade. Makron Books; McGraw-Hill, 1992.
- [13] JENKINS, Nina E.; GRZYWACZ, David. Quality control of fungal and viral biocontrol agents-assurance of product performance. Biocontrol Science and Technology, v. 10, n. 6, p. 753-777, 2000.
- [14] PALADINI, Edson Pacheco. Gestão da qualidade: teoria e prática. In: Gestão da qualidade: teoria e prática. 2010.

Diagnostic Study of Troglodytic Landscapes in the Zone of the Ancient Matmata in the South-East of Tunisia

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Abstract—This study has been interested in the diagnostics of the landscape of the city of the ancient matmata which comes from the governorate of gabes situated southeast of tunisia. Objectives: the purpose of this research is to understand the part of integration which the population of this area adopted on the function of the relief and the natural data omnipresent, supporting this appearance of the local landscape, as well as identify ancestral techniques used by the inhabitants for the conservation of the landscape of arid zones while taking profit. A study by multi-scale analysis and analysis of the different data provided by the ministry of equipment, the national institute of heritage and the medina safeguard association, accompanied by a socio-economic survey land and the direct contact of local actors, has permitted to characterize these fragile and specific landscapes. Analysis of the various topographic cards with matmata land use cards allowed us to know the history of this area and reconstitute the manner that our ancestors have adopted to produce their hollow fireplaces at the level of this landscape riche en relief. We note from the investigation that the traditional practices of protection of the arid relief by the production of troglodytic habitats underground are respectful of nature, increasing the remarkable ecological and sustainable territorial development. The human habitat of the matmata area is typical thanks to a rich and diversified local know-how, which emerges a natural landscape with a very important value. this value can be envisaged by the decision-makers to install projects south of tunisia and make our heritage benefits.

Keywords— integration party, local landscape, conservation, traditional practices, troglodyte habitats, know-how.

I. INTRODUCTION

The Tunisian South is gradually emerging from its isolation. Gabes is already a large modern industrial center. Its influence will only increase in the course of days on the region of which it is the metropolis (...) Tomorrow, the Tunisian South will inevitably have another face. So it is urgent to take snapshots of a world that will soon be no longer the same? (Abdesmad ZAIED: The world of the ksours of the Tunisian South.). In the midst of an arid and ungrateful nature, which incites to insecurity, the troglodyte works adorn their majestic masses with the peaks and ridges of the Tunisian South. Their number is imposing: 150 of which 70 are listed at the end of the book. They intrigue and sharpen curiosity, and modern man today comes to rest in their ghorfas for a moment in the age of the caves. (M.TALBI-H.DJAIT-

F.Dachraoui-M.A.M'RABET: History of Tunisia: The Middle Ages.

These dwellings are built at the base in order to cope with the heavy heat waves in the Matmata region several times a year. This particular arrangement of the habitat makes it possible to penetrate the light in the underground rooms while maintaining coolness in the warmest summer. (Ibn KHALDOUN: Kitab al ibar) At the level of this study we will explain the logic adopted by the ancestral population of southern Tunisia to integrate their architectural works according to each typology of reliefs and natural data of the occupied environment while ensuring the conservation of the local landscape of the arid zones. The study area focuses on the south of Gabes, the country of Ourghamma, more precisely the town of Matmata which constitutes an essentially mountainous region.

This area was chosen because of the existence of the greatest concentration of Troglodyte Habitats, under different typologies, which clearly shows the interaction between Man and nature.

II. MATERIAL AND METHODS

1. Presentation of the study area

Situated to the southeast of Chott el-Jérid, in the foothills of Djebel Dahar, the ancient Matmata mountains

dominate the vast plain of the Djeffara and form a cuesta (515 meters) uncovered in the limestone and upper Cretaceous marls and Through various wadis.

The village is about forty kilometers south-west of Gabes. Surrounded by mountainside, 600 meters above sea level, this village has 2,116 inhabitants in 2004. It is renowned for its remarkable cave dwellings which make it one of the high places of Tunisian tourism. (Abdesmad ZAIED: The world of the ksours of the Tunisian South.)

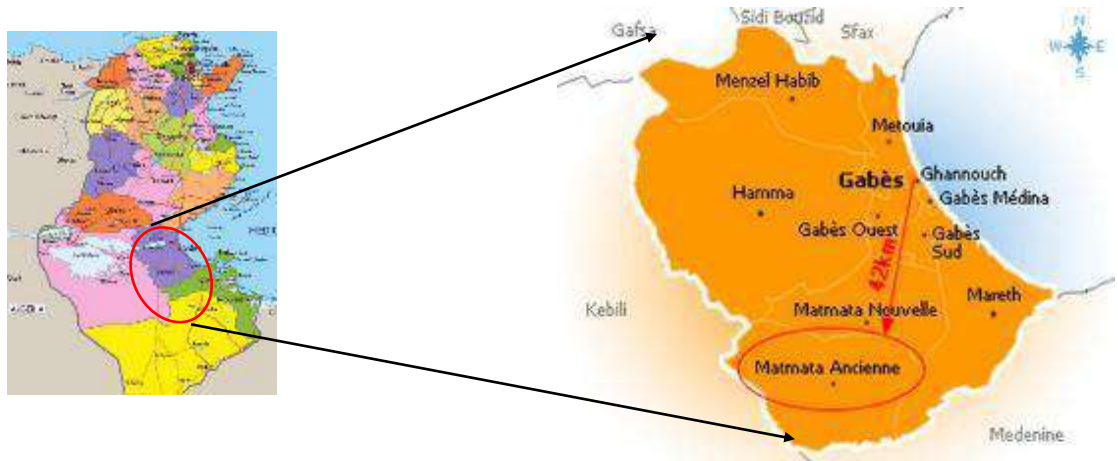


Fig.1: Location map of the town of ancient Matmata in Gabes

2. Methods

This research project aims to provide an update on the situation of troglodyte works in the town of Matmata and to study the opportunity for sustainable development in the region, based on the improvement of the natural landscape. The originality of the methodological approach used in this research is the application of complementary methodological tools to approach the decision support and the management of the exploitation of the troglodyte heritage with a view to conserving and enhancing the landscape that shelters them.

2.1. Spatial analysis

To optimally and efficiently intervene in the old urban fabric of the town of Matmata, we have opted for a methodological approach that includes two phases:

First phase: Analysis of statistical data

The collection of general data on troglodyte habitats to place it in the overall context through a reading of the statistical data required by the Ministry of Equipment and the National Heritage Institute. - Review of data extracted from GIS: Analysis of the land use database Map of the Matmata area and the topographic map of Matmata to differentiate the different reliefs and characterize the

typology of troglodyte integration according to the relief.

Phase 2: Analysis of field data

Since independence, a cultural openness to the world has changed the references that guided all human realization. Several practices, ideologies, habits have been modified or even squarely changed. Towards a new development approach, with a modernist horizon and a revolutionary image of the country, all kinds of realization with traditional roots have gradually lost their social position on the road to development. (Abdesmad ZAIED: The world of the ksours of the Tunisian South.) Among these works, the Troglodyte architecture of the arid zones was perceived as primitive and outdated, to be surpassed insofar as the Troglodytic spirit could not be part of the modernist aspect sought. So we started to build new cities in the south, on plains closer to the big cities. One can cite the case of Matmata (Southeast Tunisia), which is located in a mountainous area, so we went down to the plain to found the town of La new Matmata, close to the city of Gabes. Many other examples can be enumerated, where the term "New" is added to the old denomination to found new cities with more modernist images, eg New Zraoua, New Guermesssa, etc. The old rustic towns are now conglomerations with low concentrations of populations.

(Abdesmad ZAIED: The world of the ksours of the Tunisian South.)

In order to characterize the exploitation rates of the various troglodyte works, we develop operational parameters based on several surveys: habitat area, habitat occupation, type of activity, state of conservation ... these investigations have affected a sample Representative of 50 habitats in two areas of Matmata: Untouched and undisturbed cave area and area where troglodytes have been restored and converted. The usual statistical analyzes identified the operating systems in the study area.

2.2. Landscape reading of arid zones using the Neuray citation method

In order to determine the value of the landscape by the Neuray scoring method, a visit to the Matmata was necessary. Three observation sites were selected. The geographical coordinates N and E taken by the GPS for each observation point are converted into metric coordinates by a "GeoCalc" application (Saadaoui et al., 2014). The citation method only provides landscape values; It is based on an analysis of points of view taken at crucial places. It provides both an overall landscape value and a separate assessment of the various essential elements. The method takes into account the principle of reciprocity (if I see that I am seen) (Toussaint, 2009). In

each view, more data is determined: • The length, orientation and width of the view • The vertical dimension of the view • Valuation factors • The value of the base of the view. The base value of the view is calculated using the following formula: $V = L \times R \times S$. The base value of the view represents a current view of the landscape from a point of view.

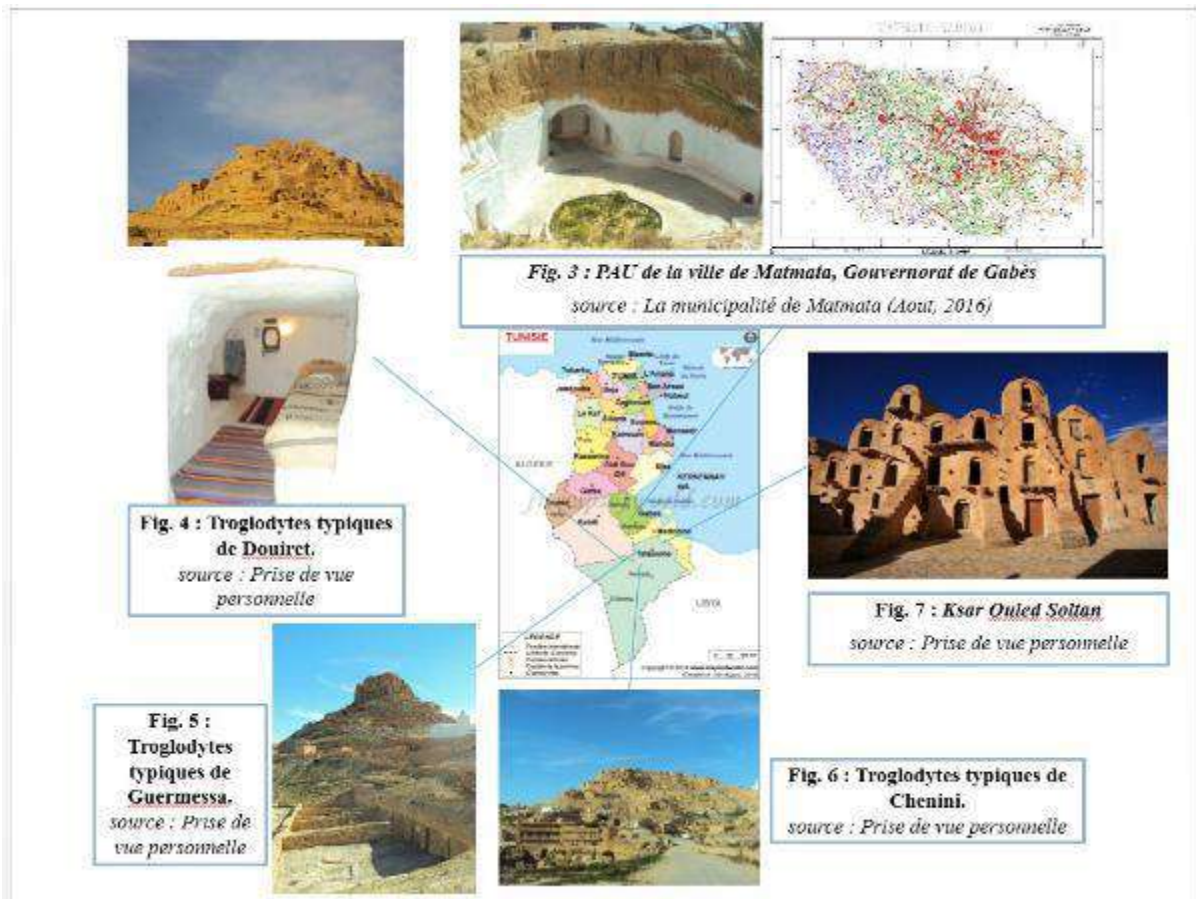
L: Width of the view

A: The vertical dimension of the view

S: valuation factor = $1 + T / 10$

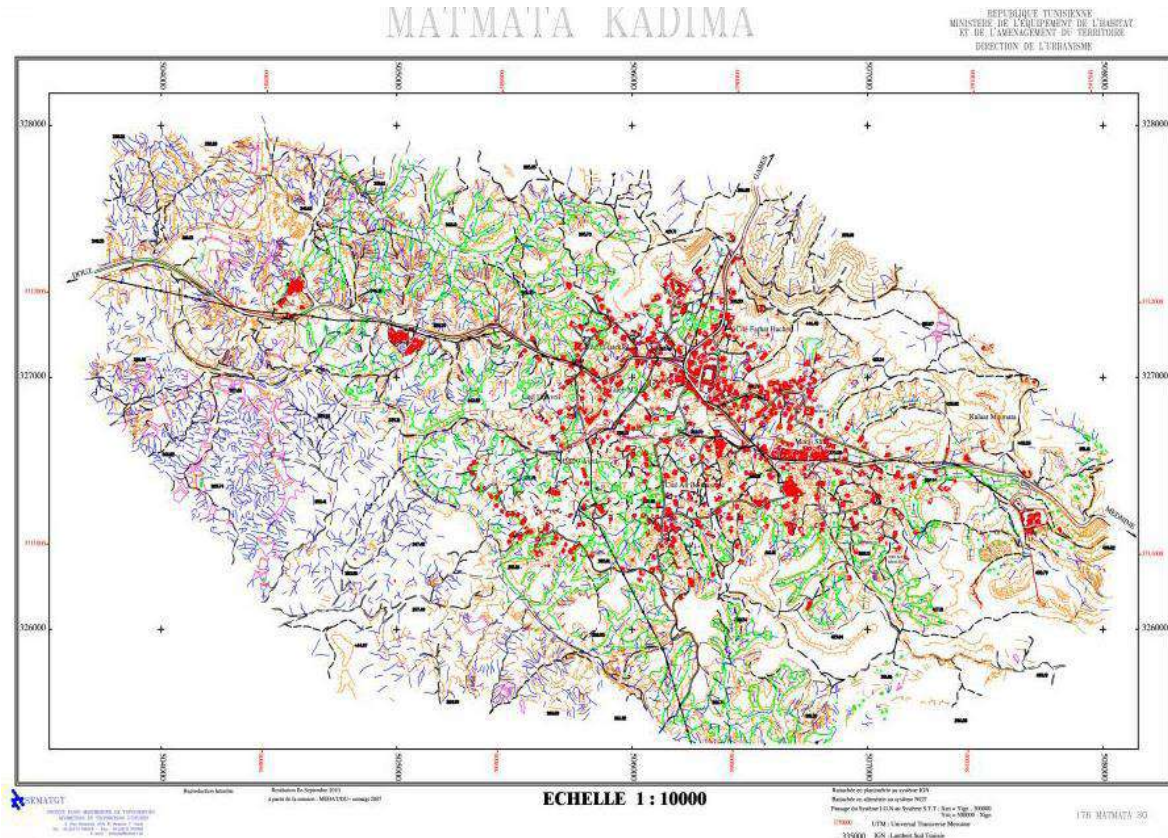
Table 1. Characteristics of viewpoint

Caracteristics	Locations of chosen sites	The southern Tunisia	
		Station 1	Station 2
The view direction		200° North	200° North
Length of view (he)		2.4	7.6
Visual angle of vertical dimensions (°)			
α		-10	-7
β		20	-14
Δ		30	20



III. RESULTS

MATMATA KADIMA



- Urban tissue of troglodytes reconvered
- Farms-Jessours
- Untasked Cave Troglodytes
- Unused Hills

Fig.2: Land use map of ancient Matmata

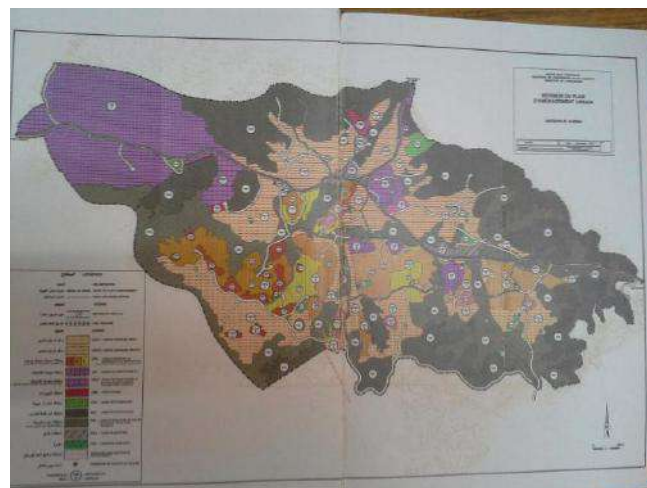
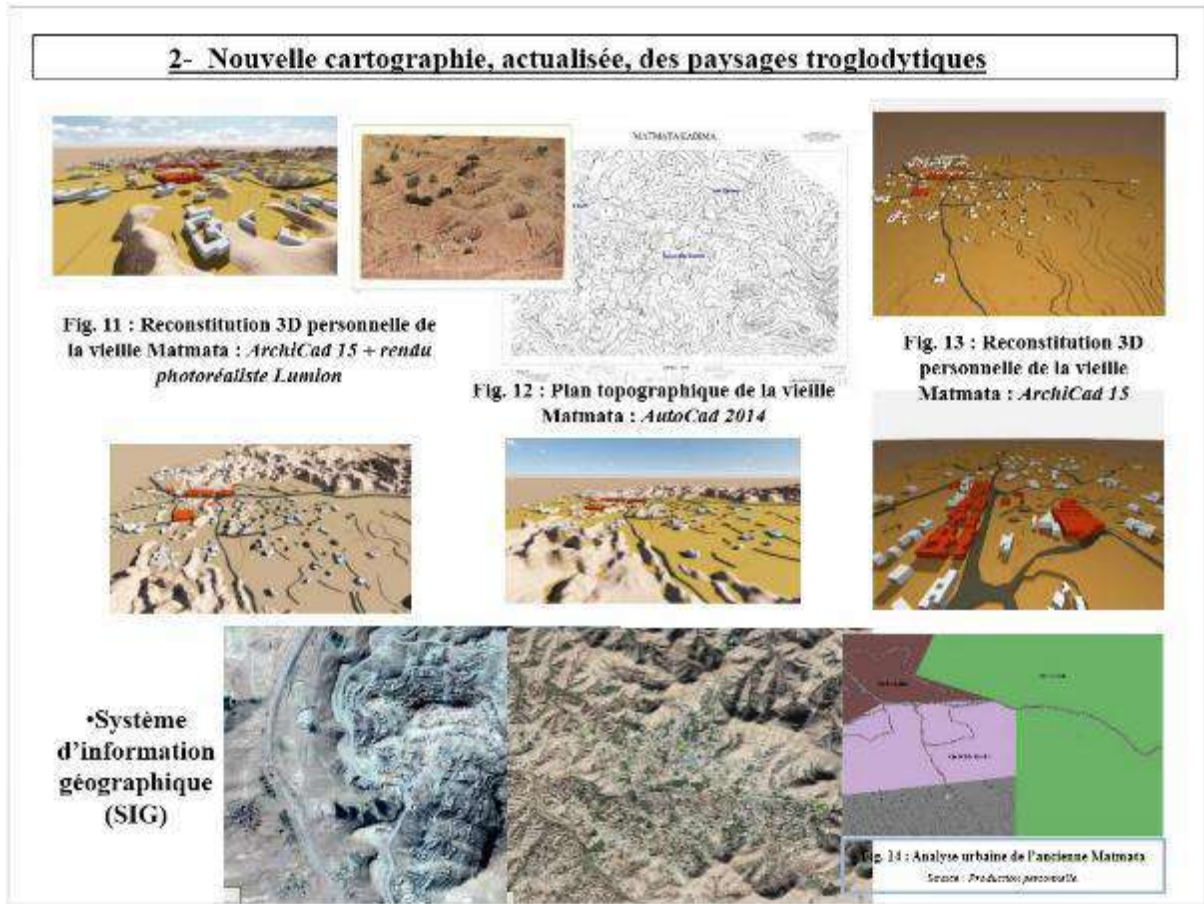


Fig.3 : PAU of the town of the ancient Matmata



It is important to clarify the following distinction: As long as it remains virgin, it is called nature. Following human intervention, the name changed to "landscape". (André TOUSSAINT: Reading of the Landscape)

The nature of the occupied environment which is characterized by its constraints and its potential, translated according to the culture and manners of the occupants, as well as the tools available to them, constitutes a generator of architectural modes and adequate and optimal landscape management.

There are three general typologies of sites in which our ancestors designed their habitats: (Mongi BOURGUOU: Atlas of landscapes of Tunisia.)- Defensive sites, perched on hills, spurs and pitons hardly accessible -Mounting eminences more easily accessible-Plains We notice that each type of relief adapts a modality of architectural response that is well adapted and well adapted given accessibility, orientation, techniques of realization, etc.

-The fight against desertification and the reduction of silting

According to its morphology, location, proportions and frequency of localization, underground Troglodytes are an active factor in the stabilization of karstic soils (karst is a geomorphological structure resulting from the water

erosion of all soluble rocks , Mainly of carbonate rocks, mainly limestones).

These soils are desert, arid, lacking dense vegetation cover to protect them from wind and stormwater runoff.

- Optimal integration with the landscape

Our ancestors have made a choice of occupying the landscape, which is distinguished and subtle, prompting us to study it more closely to reveal the corresponding reading code.

It is a question of perceiving the site not as a support on which one is indebted for the implantation of a chosen standard housing model, but rather as being a kind of raw material on a large scale, carving and shaping Organic and flexible.

This mode of habitat greatly enhances the potential of the occupied site by being grounded in the mass and constituting with the natural relief only a single entity balanced and in synergy. It is a question of inhabiting the landscape, it is not about implanting an architecture in a natural landscape but rather we talk about architectural landscape (Marinella ARENA: Ksour), since, in this case, architecture and landscape are the subject of a similar picture.

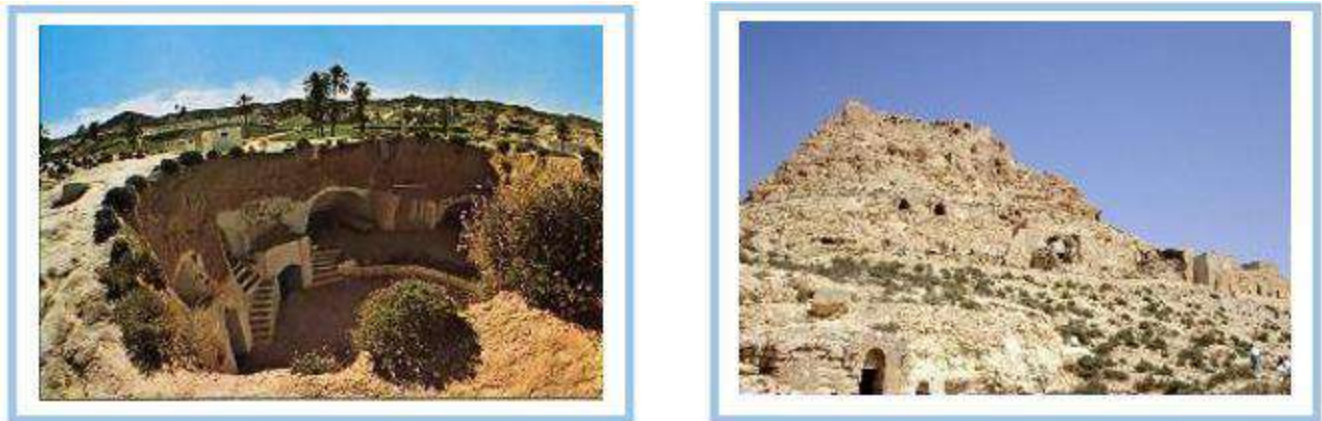


Fig.4: Different landscape integration of the troglodytes of the ancient Matmata.

-Natural regulator of climatic environments: isomorphism of houses

The earth and the mountains naturally balance the internal climate with the external climate by regulating the temperature, dissipating it when the heat is superior to its exterior to create freshness or, on the contrary, by the release of the Energy stored in the form of heat, when it is colder than inside (Habitat-Bulles.com).

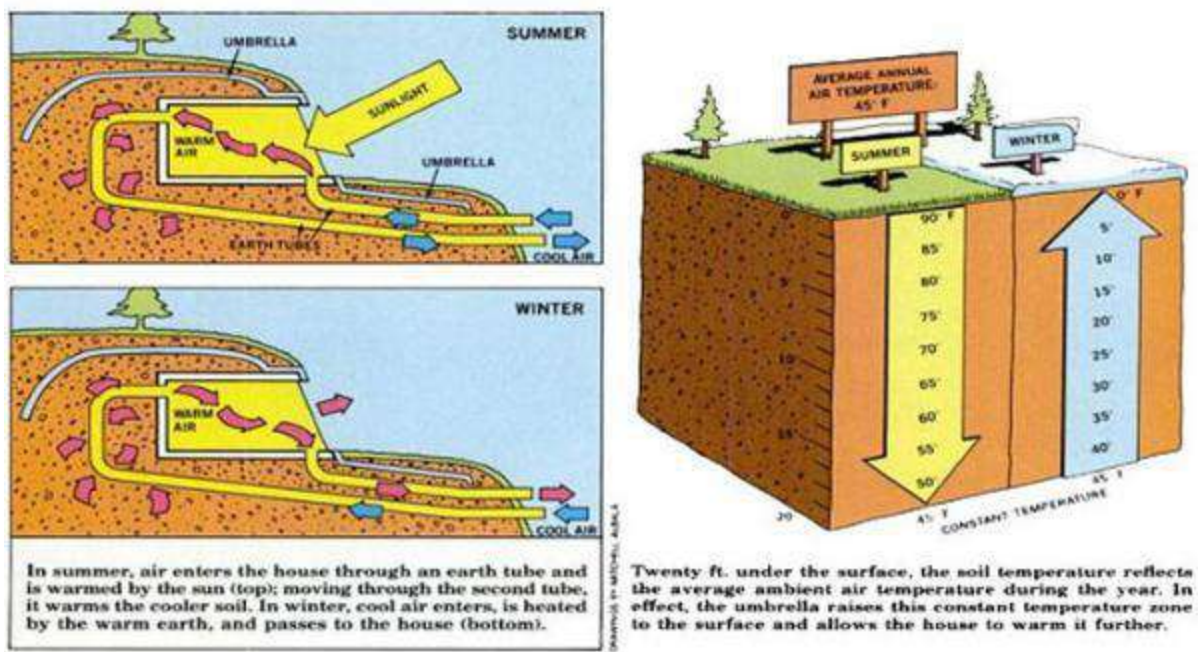
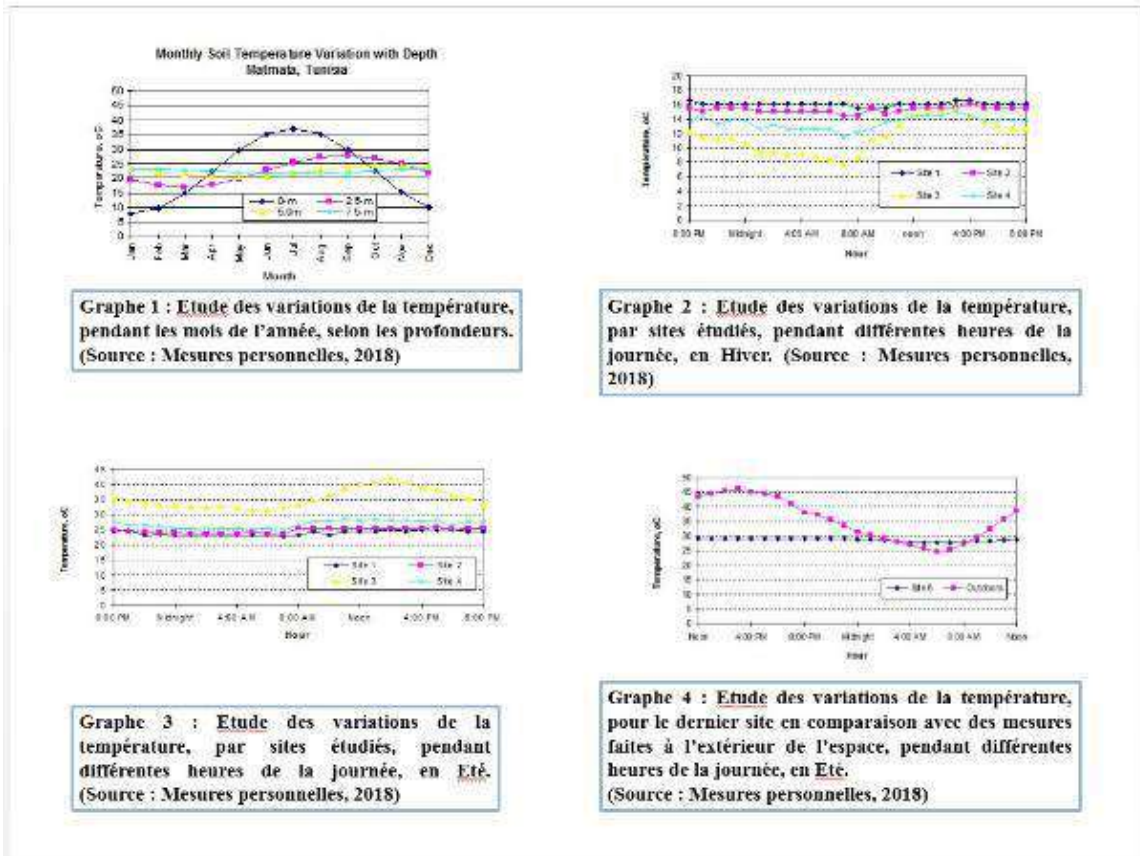


Fig.5: Phenomenon of isomorphism. (personal measurement)



Considering the criterion of natural regulation of climatic atmospheres, the energy needs to heat up or provide freshness become minimal and not imposing view that this Architectural mode is not energy-intensive. (Habitat-Bulles.com).

-Ecological architecture, sustainable

In addition to the two previous criteria for natural regulation of climatic environments leading to energy saving, there is another basic criterion of ecological architecture, which is defined by the economy of building materials (Habitat-Bulles. Com), since our building is a

sculpture inside a hill or a mountain, with a whitewash and woodwork based on palm trunks. As a result, there is no need to look for materials elsewhere.

-Special and unmatched atmosphere

As is the case for any sculptural work, the result of uniqueness, authenticity and kinesthesia is assured. (Françoise Monnin: Modern sculpture.)

The irregular walls in continuity being only one global entity with the non-planar roof, constitute the sources of an infinite artistic architectural production.

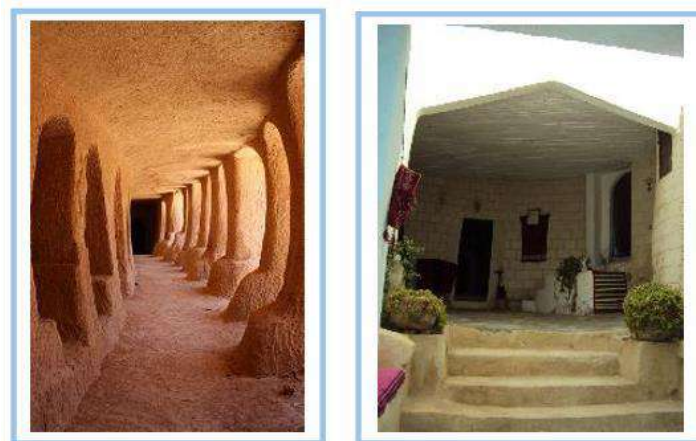


Fig.6: Particularly distinguished internal environments.

-Structural research constraint minimized

This prowess is explained as follows: At the moment when it is no longer a question of creating supports and completing the realization by creating a roof along its supports, taking into account the dimensions of the various components of this variable system Multiple,

every designer finds happiness to create and render real and existent any atmosphere to which he has thought, far from the technical constraint, one is only concerned with surpassing his imagination by manipulating the mass of matter.

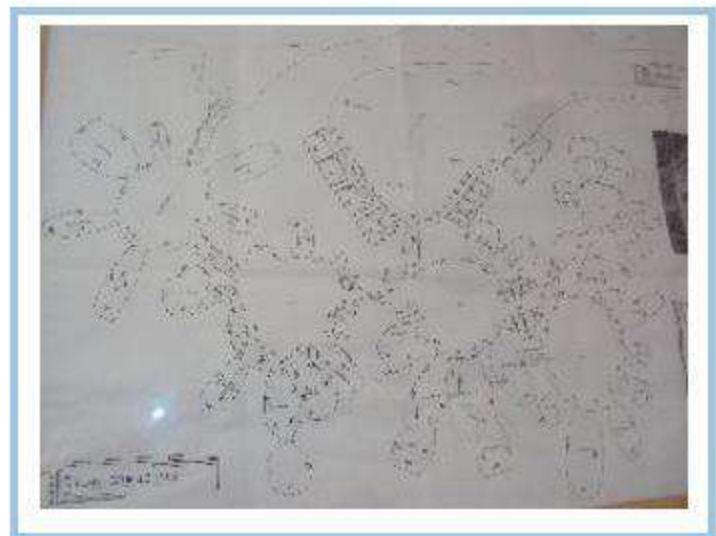


Fig.7 : Free spaces with imposing heights.

An Architectural model is a multi-component system, which is one of several possible responses to a set of needs and uses.

These needs are predefined according to the practices (traditions and customs), the standard of living and the environment that will host the project (geography, bioclimate, accessibility, availability of materials, availability of equipment, etc.).

The troglodyte architecture constantly reminds us that this form of appropriation of space constitutes an inseparable part of the landscape which is omnipresent, thus inciting

us to bring out all the rules of landscape, which gave rise to this modality of To understand the space and to integrate in the site, so as to have created an authentic work of occupation of the territory. It is about Habit the landscape: Creation of architectural landscape or landscape architecture par excellence.

As a result, the architectural work Troglodyte emphasizes the reconciliation between inhabited environment and human being as occupant of this environment, valuing it. Landscape value of different areas of the ancient town of Matmata.

We intend to make explicit the modification of the use of troglodyte habitats and its impact on the landscape and urban image. For this reason, at the level of the old Matmata, the differentiation between the abandoned troglodyte areas and the areas where the inhabitants intervened to modify the troglodytes was detected and introduced a new architecture in the vicinity, and we then discussed the comparison .

We estimated the landscape value of the two points of view chosen from the sites visited in Matmata (Figure 8). The selected viewpoints are characterized by more or less harsh reliefs, a low presence of rainfed agricultural practices (olive trees) and a large presence of troglodyte habitats, especially underground, that harmonize the different components of the natural landscape having undergone different rates Human intervention.

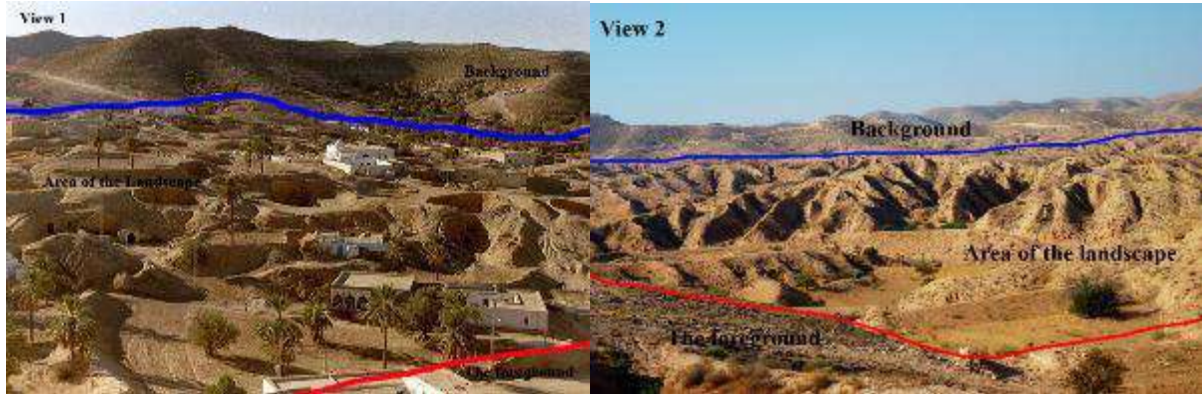


Fig.8 : Identification of the landscape area with selected views in ancient Matmata

Table 2. Valorizaion factors

Valorisation factors	View 1	View 2
Présence de nouvelles constructions	5	-
Presence of the rocks	5	5
Size and quality of the open space in front of the viewer	4	7
Presence successive planes	6	6
Framing and polarization of view	5	6
Quality of the ridgeline	4	5
Accentuation of natural landforms	5	7
Visual quality of communication routes	5	6
Integrity	7	7
Total (T)	46	49
$S = 1 + T/10$	5.6	5.9

After calculating the V-value of each observation site, we found that the high value of these views exceeded 60. (Table 3)

Table 3. Values of views (V).

	L-Length of view : $1/2 \times 10 \times \log_{10} 1$	R : Vertical dimension of view : $1 + \sin \alpha + \sin \beta + \sin \delta + d/100$	S Valorisation factors	V =L * R *S
Site 1	4.377	2.468	5.6	60.49
Site 2	10.14	1.428	5.9	85.43

IV. DISCUSSION

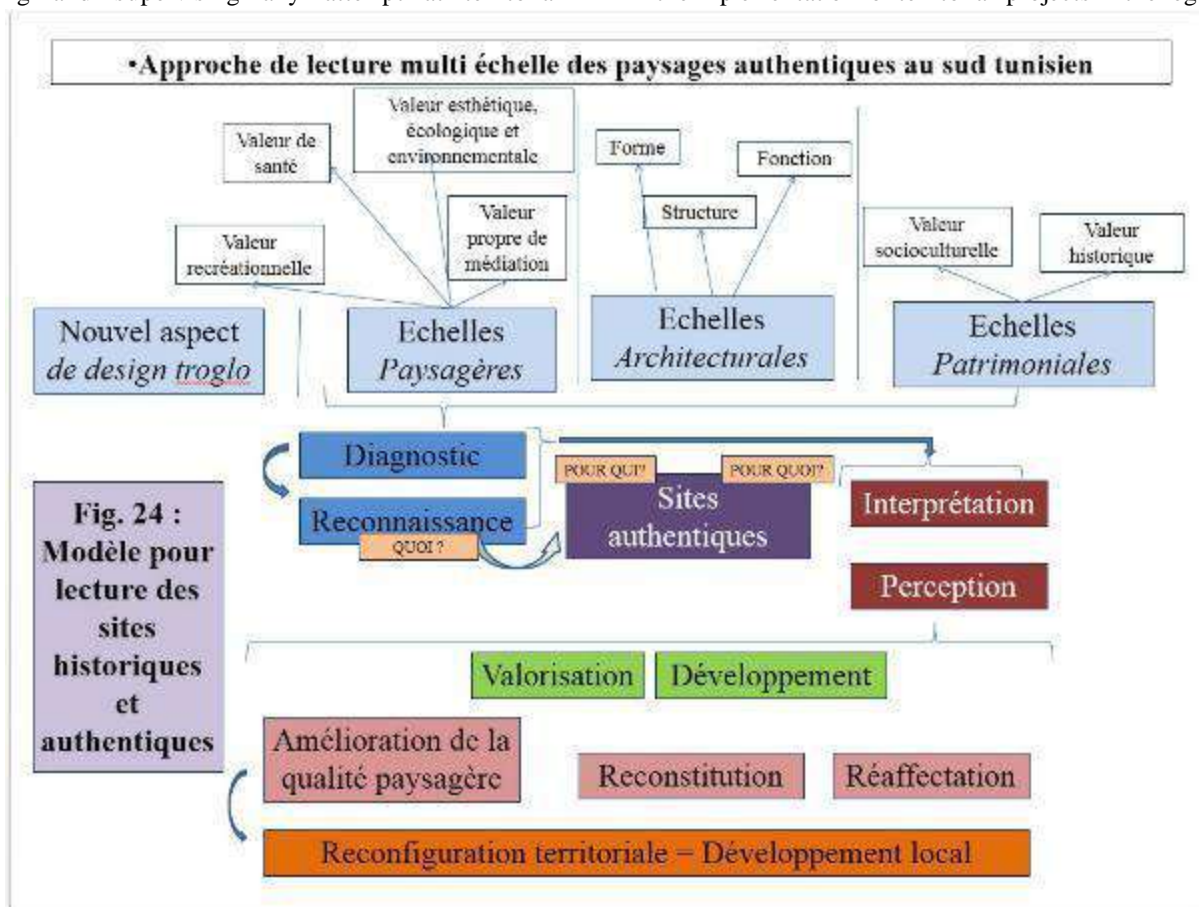
We have tried to characterize the troglodyte landscapes of the region of the old Matmata. We analyzed landscape integration systems from habitats to the study area using a reading map and data analysis and survey.

The results of the first part of this study showed that the rustic troglodyte works of the old Matmata have reached

the limit of not being able to meet the new needs of the population. This change in morals prompted some inhabitants to seek an adaptation of their rustic troglodyte habitats to their modernized daily. Most of the other troglodyte structures have been abandoned to ruin. In this way, we have touched the genesis of a new urban image that constitutes, more exactly, the mutation of the old

traditional rustic urban image. This change threatens to have serious consequences for the landscapes of the city of the old Matmata, insofar as one is forced to integrate all the activities associated with the new modern way of life, namely environmental pollution, vehicular congestion, Noise, earthworks. All its activities constitute real aggressors of the fragile and particular landscapes of the area of the old Matmata. All these findings prompt the regularization of the unbalanced and anarchic exploitation of the troglodyte heritage in the old Matmata, as well as directing and supervising any attempt at territorial

development towards a rational use and in harmony with the landscape ensemble, such as the producers Ancestral rustic troglodyte works have enhanced this landscape. The evaluation of these landscapes by the Neuray citation method has shown us a landscape value that exceeds 70, the site of study is characterized by a high landscape value caused by the presence of anthropogenic action in favor of the " Ecosystem and the preservation of the natural landscape of the mountains. These results can be taken into account by policy makers and shareholders in the implementation of territorial projects in the region.



V. CONCLUSION

This study remains a means of determining the typology and the different forms of troglodytic architecture. It was also an opportunity to showcase the potential of this way of housing the landscape. On the other hand, these authentic and typical works have been presented as areas favorable to the development of cultural and ecological tourism. This architectural landscape, constituting a true natural force of a patrimonial character, requires a modeling and a popularization having a tourist aspect. Troglodytic landscapes and their environments (agricultural, historical, urban) are a legacy that transcribes a know-how that highlights the fact that the Troglodytic habitat mode constitutes not only an

architectural, landscape and cultural heritage, but Essentially a force of nature.

The natural space, urban and agricultural, has undergone mutations throughout history. The preservation of this authentic and unique architectural mode of heritage must determine, on the one hand, a certain singularity which expresses, in a way, the richness of a historical landscape. On the other hand, the emergence of an intelligibility of adaptation and management of well-defined data that give priority today to a better living environment and gives its regions their natural, original and artistic character.

REFERENCES

- [1] André TOUSSAINT (2002). "Reading the Landscape".

- [2] Mongi BOURGUOU (April 2005) "Atlas of landscapes of Tunisia". University Publishing Center, Tunisia.
- [3] Abdesmad ZAIED (2006). "The world of the ksours of the Tunisian South". University Publishing Center, Tunisia.
- [4] Françoise Monnin (October 2007). "Modern sculpture". Scala edition.
- [5] M. TALBI-H.DJAÏT-F.Dachraoui-M.A.M'RABET "History of Tunisia. The Middle Age. Tunisian Broadcasting Corporation".
- [6] Ibn KHALDOUN. "Kitab al-Ibar".
- [7] Regional Commission for Agricultural Development (CRDA). (2004). Activity Reports. pp 66: 24.
- [8] Republic of Tunisia Ministry of Environment and Spatial Planning. (2001). Initial communication of Tunisia to the United Nation Framework Convention on Climate Change.
- [9] Saadaoui I., Ilahi H., R. Bryant Christopher et Rejeb H. (2014). The Landscapes of Mountains in the Northeast of Tunisia: Evaluation Essay of Landscape Potential of Djebel Zaghouan. *European Academic Research*. Vol 2, Issue5, 6798 – 6812.
- [10] TOUMI Labib (2016). Photos taken during the visit of the south-east of Tunisia - Southern Visit. ISA Chott Mariem - Research Unit of Horticulture, Landscape and Environment.

Functional Product of Graphs: Properties and applications

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ABSTRACT. This paper presents a generalization of the cartesian product of graphs, which we call the functional product of graphs. We prove some properties of this new product, and we show that it is commutative, associative under certain conditions, and it has a neutral element, which consists of a single vertex without edges (the trivial graph). We present a characterization of the graphs, which can be obtained from functional product of other graphs. We prove that the maximum degree of the product graph is the sum of the maximum degrees of the factor graphs, and we present conditions that ensure the connectedness of the product graph. Finally, we present an application of the functional product of graphs, in which we prove some results that allow to generate graphs that admit an equitable total coloring, with at most $\Delta + 2$ colors.

Keywords: Functional product of graphs; Properties; Equitable Total Coloring.

1 Introduction

The cartesian product of graphs was first defined by Sabidussi [14] and Vizing [18] in the 1960's. Since then, a lot of work has been done on various topics related to the product graph. The product graphs have numerous applications in diverse areas, such as Mathematics, Computer Science, Chemistry and Biology [6]. Furthermore, the cartesian product presents some important algebraic properties. These properties were investigated, independently, by Sabidussi [14] and Vizing [18]. They showed that if we identify isomorphic graphs, then the cartesian product is commutative, associative, and it has a neutral element, which consists of a single vertex without edges (trivial graph). They also demonstrated that each connected finite graph has a decomposition into prime factors that is unique except for isomorphisms. Later, several works were done studying the behavior of the cartesian product with respect to the invariants of graphs. [6, 1, 8, 13, 17].

The total coloring was introduced independently by Behzad [2] and Vizing [19], and both conjectured that every graph admits a total coloring with at most $\Delta + 2$ colors. The total coloring of cartesian product of graphs has been investigated by different authors [6, 12, 15, 16, 22, 23]. In [6], Kemnitz and Marangio investigated the total chromatic number of cartesian product of complete graphs, cycles, complete graphs and bipartite graphs, and cycles and bipartite graphs. In [15, 16], the total chromatic number of the cartesian product of two

paths, a path and a cycle, a path and a star, a cycle and a star, and two cycles are determined. Some partial results on the total coloring of cartesian products of several paths and several cycles are contained in [22]. In [23], Zmazek and Zerovnik generalized the result on [12], determining an upper bound for the total chromatic number of a graph.

Recently, Lozano *et al.* [9] have studied some relationships between equitable total coloring and range vertex coloring in some regular graphs. They proved that if a regular graph admits a 2-distant coloring with $\Delta + 1$ colors, then the coloring of the vertices can be completed to an equitable total coloring with at most $\Delta + 2$ colors. In [7] Lozano *et al.* showed the equivalence of a range coloring of order Δ and the two-distant coloring [3]. These results motivated us to study the possibility of constructing families of regular graphs that admit a 2-distant coloring with $\Delta + 1$ colors.

In the section 3 of this paper, we introduce the concept of the functional product of graphs, and we show that it is a generalization of the cartesian product of graphs, and we prove some properties. In Section 4, we present an application of the functional product of graphs, and we prove some results that describe a method for obtaining harmonic graphs. We are going to show that all harmonic graphs admit an equitable total coloring with at most $\Delta + 2$ colors (i.e. it satisfies Wang's conjecture [20]). In this text, the graphs are simple, not oriented and without loops.

2 Basic Definitions and Notations

Below, we list the notations to be used throughout this paper:

- $\{u, v\}$ or uv denotes an edge of the graph G , in which u and v are adjacent;
- $d_G(v)$ or $d(v)$, if there is no ambiguity, denotes the degree of a vertex v in the graph G ;
- $\Delta(G)$ or Δ , if there is no ambiguity, denotes the maximum degree of the graph G ;
- $N_G(v)$ or $N(v)$, if there is no ambiguity, denotes the set of all adjacent vertices to a vertex v in the graph G ;
- $F(X)$ denotes the set of all bijections of X in X ;
- $D(G)$ denotes the digraph obtained by replacing each edge uv of the graph G by arcs (u, v) and (v, u) while maintaining the same set of vertices;
- \mathcal{D} denotes the set of digraphs that satisfy the following conditions:
 1. (u, v) is an arc of the digraph if and only if (v, u) is also an arc of this digraph.
 2. No two arcs are alike.
- $\vec{G} \in D, G(\vec{G})$ denotes the graph obtained by replacing each pair of arcs (u, v) and (v, u) of \vec{G} for the edge uv while maintaining the same set of vertices;
- $E(X)$ or E , if there is no ambiguity, denotes the set of edges (arcs) of the graph (digraph) X ;
- $V(X)$ or V , if there is no ambiguity, denotes the set of vertices of the graph (digraph) X ;

Definition 2.1. [4] Let $G(V, E)$ be a graph, $S \subset (E \cup V)$ be a set, k be a natural number, and $C = \{c_1, c_2, \dots, c_k\}$ be an arbitrary set whose elements are called colors. A coloring of the graph G with the colors of C is an application $f : S \rightarrow C$.

In the above definition, if $S = V$ then f is a **vertex coloring**. In the case that $S = E$, this is called an **edge coloring**. Finally, if $S = (E \cup V)$, then f is called a **total coloring**. If $x \in S$ and $f(x) = c_i$, for $i \in \{1, 2, \dots, k\}$, then we say that x owns or is colored with the color c_i .

Definition 2.2. [4] Let $G(V, E)$ be a graph, $S \subset (E \cup V)$ be a set, and $C = \{c_1, c_2, \dots, c_k\}$ be a set of colors, in which k is a natural number. A coloring $f : S \rightarrow C$ with colors from C is called a **proper coloring** if for every pair $x, y \in S$ with x adjacent or incident to y , $f(x) \neq f(y)$.

From now on, every coloring considered in this paper is going to be proper and surjective unless it is explicitly stated otherwise.

Definition 2.3. [21] Let $G(V, E)$ be a graph, $S \subset (E \cup V)$ be a set, and $C = \{c_1, c_2, \dots, c_k\}$ be a set of colors, in which k is a natural number. A coloring $f : S \rightarrow C$ of the graph G with colors from C is called an **equitable coloring** if for every pair $i, j \in \{1, 2, \dots, k\}$ we have that $||f^{-1}(c_i)| - |f^{-1}(c_j)|| \leq 1$, in which $|f^{-1}(c_i)|$ and $|f^{-1}(c_j)|$ are the cardinalities of the sets of the elements of S that have the colors c_i and c_j respectively.

Definition 2.4. [5] Let $G(V, E)$ be a graph and $C = \{c_1, c_2, \dots, c_k\}$ be a set of colors, in which k is a natural number, an application $f : S \rightarrow C$ is called a **range vertex coloring of order k** of G . If for all $v \in V$, such that $d(v) < k$, then $|c(N(v))| = d(v)$; otherwise $|c(N(v))| \geq k$, in which $|c(N(v))|$ is the cardinality of the set of colors used in the neighborhood of v .

Observe that range coloring generalizes some known vertex colorings. The usual vertex coloring of G is a range coloring of order one. The equivalence of a range coloring of order Δ and the two-distant coloring is showing in theorem 2.1.

Definition 2.5. [3] Let $G(V, E)$ be a graph and $C = \{c_1, c_2, \dots, c_k\}$ be a set of colors, in which k is a natural number. A coloring $f : V \rightarrow C$ with colors from C is called a **two-distant coloring** if every pair of vertices with distance 1 or 2 has different colors.

Theorem 2.1. [7] Let $G(V, E)$ be a graph and $C = \{c_1, c_2, \dots, c_k\}$ be a set of colors, in which k is a natural number. A coloring $f : V \rightarrow C$ is a range coloring of order Δ if only if f is a **two-distant coloring**.

3 Functional Product of Graphs

The main objective of this section is to present the definition of the functional product of graphs and to prove some properties of this new product. For this purpose, it is necessary to define applications, called linking applications, that associate each edge of a factor graph with a bijection defined on the set of vertices of another. This bijection indicates the manner in which the connection of the vertices of the product graph will be performed. We are also going to show also that the cartesian product of graphs can be viewed as a particular case of the functional product, in which all edges are associated to the identity application.

Definition 3.1. The digraphs $\vec{G}_1(V_1, E_1)$ and $\vec{G}_2(V_2, E_2)$ are functionally linked by applications $f_1 : E_1 \rightarrow F(V_2)$ and $f_2 : E_2 \rightarrow F(V_1)$ if the following hold:

1. For all arc $(u, v) \in E_1$, if $(v, u) \in E_1$ then $f_1((u, v)) = (f_1((v, u)))^{-1}$.
2. For all arc $(x, y) \in E_2$, if $(y, x) \in E_2$ then $f_2((x, y)) = (f_2((y, x)))^{-1}$.

3. For every pair of arcs $(u, v) \in E_1$ and $(x, y) \in E_2$, we have that $f_2((x, y))(u) \neq v$ or $f_1((u, v))(x) \neq y$.

The applications f_1 and f_2 are called **linking applications**.

Definition 3.2. Let $G_1(V_1, E_1)$ and $G_2(V_2, E_2)$ be graphs. If $D(G_1)$ and $D(G_2)$ are functionally linked by applications $f_1 : E(D(G_1)) \rightarrow F(V_2)$ and $f_2 : E(D(G_2)) \rightarrow F(V_1)$, then the graphs $G_1(V_1, E_1)$ and $G_2(V_2, E_2)$ are said to be **functionally linked** through the same applications.

Definition 3.3. Let $\vec{G}_1(V_1, E_1)$ and $\vec{G}_2(V_2, E_2)$ be digraphs that are functionally linked by applications $f_1 : E_1 \rightarrow F(V_2)$ and $f_2 : E_2 \rightarrow F(V_1)$. The functional product of the digraph \vec{G}_1 with the digraph \vec{G}_2 through the applications f_1 and f_2 , denoted by $(\vec{G}_1, f_1) \times (\vec{G}_2, f_2)$, is the digraph $G^*(V^*, E^*)$ defined as follows:

- $V^* = V_1 \times V_2$.
- $(u, x), (v, y) \in E^*$ if and only if one of the following conditions is true:
 1. $(u, v) \in E_1$ and $f_1((u, v))(x) = y$;
 2. $(x, y) \in E_2$ and $f_2((x, y))(u) = v$.

Definition 3.4. Let $G_1(V_1, E_1)$ and $G_2(V_2, E_2)$ be graphs that are functionally linked by applications $f_1 : E(D(G_1)) \rightarrow F(V_2)$ and $f_2 : E(D(G_2)) \rightarrow F(V_1)$. The functional product of the graph G_1 by graph the G_2 , denoted by $(G_1, f_1) \times (G_2, f_2)$, is the graph $G(\vec{G}^*(V^*, E^*))$, in which $\vec{G}^*(V^*, E^*) = (D(G_1), f_1) \times (D(G_2), f_2)$.

Figure 1 refers to definitions 3.1 and 3.7. From the original graphs (G_1 and G_2), are generated the corresponding digraphs ($D(G_1)$ and $D(G_2)$) replacing each edge of the graphs by a pair of opposing arcs.

Note that the cartesian product of graphs is a particular case of the functional product of graphs defined above, in which f_1 and f_2 assign the identity to all arcs of the corresponding digraphs. Figures 4 and 5 exemplify this relation.

3.1 Properties

It is immediate from definition 3.3 that if identify isomorphic graphs, then the functional product has neutral element, which consists of a single vertex without edges (the trivial graph). The following theorem shows that the functional product is commutative.

Theorem 3.1. [10] Let $G_1(V_1, E_1)$ and $G_2(V_2, E_2)$ be graphs that are functionally linked by applications $f_1 : E(D(G_1)) \rightarrow F(V_2)$ and $f_2 : E(D(G_2)) \rightarrow F(V_1)$, then the graphs $G^*(V^*, E^*) = (G_1, f_1) \times (G_2, f_2)$ and $G^{**}(V^{**}, E^{**}) = (G_2, f_2) \times (G_1, f_1)$ are isomorphic graphs. In this sense, the functional product is commutative.

Proof. Let $E'_1 = E(D(G_1))$ and $E'_2 = E(D(G_2))$, we are going to prove that given two vertices $(u, x) \in V^*$ and $(v, y) \in V^*$, the edge $\{(u, x), (v, y)\} \in E^*$ if and only if the edge $\{(x, u), (y, v)\} \in E^{**}$. Applying the definition of functional product, we have that $\{(u, x), (v, y)\} \in E^*$ if and only if:

1. $(u, v) \in E'_1$ and $f_1((u, v))(x) = y$, and $(v, u) \in E'_1$ and $f_1((v, u))(y) = (f_1((u, v))^{-1}(y) = x$ or
 2. $(x, y) \in E'_2$ and $f_2((x, y))(u) = v$, and $(y, x) \in E'_2$ and $f_2((y, x))(v) = (f_2((x, y))^{-1}(v) = u$.
- Furthermore, $(x, u), (y, v) \in E^{**}$ if and only if
3. $(x, y) \in E'_2$ and $f_2((x, y))(u) = v$, and $(y, x) \in E'_2$ and $f_2((y, x))(v) = (f_2((x, y))^{-1}(v) = u$; or
 4. $(u, v) \in E'_1$ and $f_1((u, v))(x) = y$, and $(v, u) \in E'_1$ and $f_1((v, u))(y) = (f_1((u, v))^{-1}(y) = x$.

Because 1 is equivalent to 4 and 2 is equivalent to 3, the theorem is proven. \square

The following result presents a characterization of the graphs that can be obtained from functional product of other graphs.

Definition 3.5 (Graph orientation). Given a graph $G(V, E)$, the digraph $\vec{G}(V, E')$ is a G orientation if it satisfies the following conditions:

1. For all $uv \in E$, $(u, v) \in E'$ or $(v, u) \in E'$.
2. For all $(u, v) \in E'$, $uv \in E$.
3. For all $(u, v) \in E'$, $(v, u) \notin E'$.

Note that every graph has an orientation just replace each edge uv by exactly one and only one of the arcs (u, v) or (v, u) .

Definition 3.6. Let $G_1(V_1, E_1)$ and $G_2(V_2, E_2)$ be graphs, $f_1 : E(D(G_1)) \rightarrow F(V_2)$ and $f_2 : E(D(G_2)) \rightarrow F(V_1)$ linking applications. f_1 (respectively f_2) is said to be **constant** if exists an orientation $\vec{G}_1(V_1, E'_1)$ (respectively $\vec{G}_2(V_2, E'_2)$) of G_1 (respectively G_2) such that for all pair of arcs (u, v) and (x, y) in E'_1 (respectively E'_2) we have that $f_1((u, v)) = f_1((x, y))$ (respectively $f_2((u, v)) = f_2((x, y))$).

Definition 3.7. Let $G(V, E)$, $X_1 \subset V$ and $X_2 \subset V$. The sets X_1 and X_2 are called **matched** if $|X_1| = |X_2|$, and there is a matching $P \subset E$, such that every edge of P has an end in X_1 and another in X_2 , and P saturates both X_1 and X_2 .

Theorem 3.2. Let $G(V, E)$, $G_1(V_1, E_1)$ and $G_2(V_2, E_2)$ be simple graphs. There are linking applications $f_1 : E(D(G_1)) \rightarrow F(V_2)$ and $f_2 : E(D(G_2)) \rightarrow F(V_1)$, such that $G = (G_1, f_1) \times (G_2, f_2)$ if and only if exists a bijection $a : V_1 \times V_2 \rightarrow V$ that satisfies:

1. For all $v \in V_1 \times V_2$, $d(v) = d(a(v))$.
2. For all edge $uv \in E_1$, the sets $\{a((u, x)); x \in V_2\}$ and $\{a((v, y)); y \in V_2\}$ are matched. For each edge $e \in E_1$, we denote by ε_e the corresponding matching.
3. For all edge $xy \in E_2$, the sets $\{a((u, x)); u \in V_1\}$ and $\{a((v, y)); v \in V_1\}$ are matched. For each edge $e \in E_2$, we denote by ε_e the corresponding matching.
4. $E = (\bigcup_{e \in E_1} \varepsilon_e) \cup (\bigcup_{e \in E_2} \varepsilon_e)$.

Proof. Let suppose that 1, 2, 3 and 4 are true.

Let $\vec{G}_1(V_1, E_1)$ and $\vec{G}_2(V_2, E_2)$ arbitrary orientations of G_1 and G_2 respectively, for each arc $(u, v) \in E_1$, we defined $g_{(u,v)} : V_2 \rightarrow V_2$ by $g_{(u,v)}(x) = y$, in which y is such that $\{a((u, x)), a((v, y))\} \in \varepsilon_{uv}$. Similarly, for each arc $(x, y) \in E_2$ we defined $h_{(x,y)} : V_1 \rightarrow V_1$ by $h_{(x,y)}(u) = v$, in which v is such that $\{a((u, x)), a((v, y))\} \in \varepsilon_{xy}$.

We defined:

$$f_1 : E(D(G_1)) \rightarrow F(V_2) \text{ by } f_1((u, v))(x) = \begin{cases} g_{(u,v)}(x) & \text{if } (u, v) \in E_1 \\ g_{(v,u)}^{-1}(x) & \text{otherwise} \end{cases}$$

$$f_2 : E(D(G_2)) \rightarrow F(V_1) \text{ by } f_2((x, y))(u) = \begin{cases} h_{(x,y)}(u) & \text{if } (x, y) \in E_2 \\ h_{(y,x)}^{-1}(u) & \text{otherwise} \end{cases}$$

Let $G^*(V^*, E^*)$ the graph defined by $V^* = V_1 \times V_2$ and E^* is such that $\{(u, x), (v, y)\} \in E^*$ if and only if one of the following conditions is satisfied:

1. $(u, v) \in V(D(G_1))$ and $f_1((u, v))(x) = y$ or
2. $(x, y) \in V(D(G_2))$ and $f_2((x, y))(u) = v$.

Initially, we are going to prove that G^* is isomorphic to G . Note that $V^* = V_1 \times V_2$.

So, we define the bijection $b : V^* \rightarrow V$ by $b(v) = a(v)$. Let $\{(u, x), (v, y)\} \in E^*$, then:

- $(u, v) \in E(D(G_1))$ and $f_1((u, v))(x) = y$, which means that $\{b((u, x)), b((v, y))\} \in \varepsilon_{uv}$, so $\{b((u, x)), b((v, y))\} \in E$ or
- $(x, y) \in E(D(G_2))$ and $f_2((x, y))(u) = v$, which means that $\{b((u, x)), b((v, y))\} \in \varepsilon_{xy}$, so $\{b((u, x)), b((v, y))\} \in E$.

On the other hand, because of 3, if $\{b((u, x)), b((v, y))\} \in E$, we have:

- $\{u, v\} \in E_1$ and $\{b((u, x)), b((v, y))\} \in \varepsilon_{uv}$, so $f_1((u, v))(x) = y$ and $(f_1((u, v)))^{-1}(y) = x$ or $f_1((v, u))(x) = y$ and $(f_1((v, u)))^{-1}(y) = x$. In both cases $\{(u, x), (v, y)\} \in E^*$; or

- $\{x, y\} \in E_2$ and $\{b((u, x)), b((v, y))\} \in \varepsilon_{xy}$, so $f_2((x, y))(u) = v$ and $(f_2((x, y)))^{-1}(v) = u$ or $f_2((y, x))(u) = v$ and $(f_2((y, x)))^{-1}(v) = u$. In both cases $\{(u, x), (v, y)\} \in E^*$.

So, G^* is isomorphic to G .

It remains to prove that the applications f_1 and f_2 are linking applications. In fact, f_1 and f_2 satisfy conditions 1 and 2 of the linking application definition because of the way that they were defined. Now, if $uv \in E_1$ and $xy \in E_2$ are such that $f_1((u, v))(x) = y$ and $f_2((x, y))(u) = v$, then the edge $\{(u, x), (v, y)\} \in E^*$ would be a double edge. It implies that G^* (and therefore G) is not simple and this fact contradicts the hypotheses of the theorem. So, the applications f_1 and f_2 are linking applications.

Let suppose now that there are linking applications $f_1 : E(D(G_1)) \rightarrow F(V_2)$ and $f_2 : E(D(G_2)) \rightarrow F(V_1)$, such that $G(V, E) = (G_1, f_1) \times (G_2, f_2)$. We take the application $a : V_1 \times V_2 \rightarrow V$ as identity. Let $uv \in E_1$, then because of definition of linking applications $\varepsilon_{uv} = \{(u, x)(v, y) \in E : y = f_1((u, v))(x)\}$ is a matching between the sets $\{a((u, x)); x \in V_2\}$ and $\{a((v, y)); y \in V_2\}$. In a similar way, we have the matching ε_{xy} for each $xy \in E_2$.

To prove that $E = (\bigcup_{e \in E_1} \varepsilon_e) \cup (\bigcup_{e \in E_2} \varepsilon_e)$, just note that if $\{(u, x), (v, y)\} \in \varepsilon_{uv}$ or $\{(u, x), (v, y)\} \in \varepsilon_{xy}$, then $\{(u, x), (v, y)\} \in E$, and vice versa, if $\{(u, x), (v, y)\} \in E$, then $\{u, v\} \in E_1$ and $f_1((u, v))(x) = y$, in this case, $\{(u, x), (v, y)\} \in \varepsilon_{uv}$, or $\{x, y\} \in E_2$ and $f_2((x, y))(u) = v$, in this case $\{(u, x), (v, y)\} \in \varepsilon_{xy}$. So $E = (\bigcup_{e \in E_1} \varepsilon_e) \cup (\bigcup_{e \in E_2} \varepsilon_e)$, which is enough to prove the theorem. \square

Theorem 3.3. Let $G_1(V_1, E_1)$, $G_2(V_2, E_2)$, $G_3(V_3, E_3)$ be graphs, $f_1 : E(D(G_1)) \rightarrow F(V_2)$, $f_2 : E(D(G_1)) \rightarrow F(V_3)$, $g_1 : E(D(G_2)) \rightarrow F(V_1)$, $g_2 : E(D(G_2)) \rightarrow F(V_3)$, $h_1 : E(D(G_3)) \rightarrow F(V_1)$ and $h_2 : E(D(G_3)) \rightarrow F(V_2)$ linking application between respective graphs. If $h_3 : E(D(G_3)) \rightarrow F(V_1 \times V_2)$ and $t_1 : E(D((G_1, f_1) \times (G_2, g_1))) \rightarrow F(V_3)$ are defined by:

$$h_3((u, v))(x, y) = (h_1((u, v))(x), h_2((u, v))(y))$$

$$t_1(((u, x), (v, y))) =$$

$$\begin{cases} f_2((u, v)) & \text{if } \{(u, x), (v, y)\} \in \varepsilon_{uv}, uv \in E_1 \\ g_2((x, y)) & \text{if } \{(u, x), (v, y)\} \in \varepsilon_{xy}, xy \in E_2 \end{cases}$$

Then, there are linking applications $f_3 : E(D(G_1)) \rightarrow F(V_2 \times V_3)$ and $t_2 : E(D((G_2, g_2) \times (G_3, h_2))) \rightarrow F(V_1)$, such that: $((G_1, f_1) \times (G_2, g_1), t_1) \times (G_3, h_3)$ is isomorphic $(G_1, f_2) \times ((G_2, g_2) \times (G_3, h_2), t_2)$.

Proof. Let $G^*(V^*, E^*) = ((G_1, f_1) \times (G_2, g_1), t_1) \times (G_3, h_3)$ and $G'(V', E') = (G_2, g_2) \times (G_3, h_2)$ be graphs. We define the bijection $a : V_1 \times V' \rightarrow V^*$ such that $a((x, (y, z))) = ((x, y), z)$. We are going to show that G^* ,

G_1, G' satisfy the conditions of the theorem 3.2. From now on, $n_1 = |V_1|, n_2 = |V_2|, n_3 = |V_3|, V_1 = \{x_1, \dots, x_{n_1}\}, V_2 = \{y_1, \dots, y_{n_2}\}$ and $V_3 = \{z_1, \dots, z_{n_3}\}$.

Let $\{x_{i_1}, x_{i_2}\} \in E_1$, with $i_1, i_2 \in \{1, \dots, n_1\}$. Note that the sets $\{(x_{i_1}, y_j)\}$ and $\{(x_{i_2}, y_j)\}, j \in \{1, \dots, n_2\}$ are matched in $(G_1, f_1) \times (G_2, g_1)$ because $\{x_{i_1}, x_{i_2}\} \in E_1$ and $f_1((x_{i_1}, x_{i_2}))$ is a bijection of V_2 in V_2 .

Fixing $j_1 \in \{1, \dots, n_2\}$, the edge $\{(x_{i_1}, y_{j_1}), (x_{i_2}, f_1((x_{i_1}, x_{i_2}))(y_{j_1}))\} \in E((G_1, f_1) \times (G_2, g_1))$. As $t_1(e) = f_2((x_{i_1}, x_{i_2}))$, if $e \in \varepsilon_{x_{i_1} x_{i_2}}$, then for each $k \in \{1, \dots, n_3\}$ the edge $\{((x_{i_1}, y_{j_1}), z_k), ((x_{i_2}, f_1((x_{i_1}, x_{i_2}))(y_{j_1})), z_k)\} \in E^*$.

So, the sets $\{((x_{i_1}, y_{j_1}), z_k)\}$ and $\{((x_{i_2}, f_1((x_{i_1}, x_{i_2}))(y_{j_1})), z_k)\}, k \in \{1, \dots, n_3\}$, are matched in G^* . Now, if we take $j_2 \in \{1, \dots, n_2\}$, with $j_2 \neq j_1$, then $f_1((x_{i_1}, x_{i_2}))(y_{j_1}) \neq f_1((x_{i_1}, x_{i_2}))(y_{j_2})$ and the respective matchings have no edges in common. This shows that $\{((x_{i_1}, y_j), z_k)\}$ and $\{((x_{i_2}, y_j), z_k)\},$ with $j \in \{1, \dots, n_2\}, k \in \{1, \dots, n_3\}$ are matched in G^* .

Let $\{(y_{i_1}, z_{k_1}), (y_{i_2}, z_{k_2})\} \in E(G')$, we are going to analyze two cases:

case 1. If $(y_{j_1}, y_{j_2}) \in E(D(G_2))$ and $g_2((y_{i_1}, y_{i_2}))(z_{k_1}) = z_{k_2}$, then $\{(x_i, y_{j_1})\}$ and $\{(f_2((y_{j_1}, y_{j_2}))(x_i), y_{j_2})\}$, with $i \in \{1, \dots, n_1\}$ are matched in $(G_1, f_1) \times (G_2, g_1)$. As $t_1(e) = g_2((y_{i_1}, y_{i_2}))$, if $e \in \varepsilon_{y_{i_1} y_{i_2}}$, then for each $i \in \{1, \dots, n_1\}$, the edge $\{((x_i, y_{j_1}), z_{k_1}), ((x_i, y_{j_2}), z_{k_2})\} \in E^*$. Therefore, the sets $\{(x_i, y_{j_1}), z_{k_1}\}$ and $\{(x_i, y_{j_2}), z_{k_2}\}$ are matched.

case 2. If $(z_{k_1}, z_{k_2}) \in E(D(G_3))$ and $h_2((z_{k_1}, z_{k_2}))(y_{j_1}) = y_{j_2}$, just note that $h_3((z_{k_1}, z_{k_2}))(x_i, y_{j_1}) = (h_1((z_{k_1}, z_{k_2}))(x_i), h_2((z_{k_1}, z_{k_2}))(y_{j_1})) = (h_1((z_{k_1}, z_{k_2}))(x_i), y_{j_2})$ for all $i \in \{1, \dots, n_1\}$. It establishes a matching between sets and $\{(x_i, y_{j_1}), z_{k_1}\}$ e $\{(x_i, y_{j_2}), z_{k_2}\}$.

Now, it remains to prove that every edge of G^* is in any of the matchings. In fact, if the $\{((x_{i_1}, y_{j_1}), z_{k_1}), ((x_{i_2}, y_{j_2}), z_{k_2})\} \in E^*$, then one of the conditions below is satisfied:

case 1. If $(z_{k_1}, z_{k_2}) \in E(D(G_3))$ and $h_3((z_{k_1}, z_{k_2}))(x_{i_1}, y_{j_1}) = (x_{i_2}, y_{j_2})$, then $\{((x_{i_1}, y_{j_1}), z_{k_1}), ((x_{i_2}, y_{j_2}), z_{k_2})\}$ is in the matching between $\{((x_i, y_{j_1}), z_{k_1})\}$ and $\{((x_i, y_{j_2}), z_{k_2})\}$, with $i \in \{1, \dots, n_1\}$.

case 2. If $((x_{i_1}, y_{j_1}), (x_{i_2}, y_{j_2})) \in E(D((G_1, f_1) \times (G_2, f_2)))$ and $t_1(((x_{i_1}, y_{j_1}), (x_{i_2}, y_{j_2})))z_{k_1} = z_{k_2}$, we have 2 subcases:

subcase 1. If $(x_{i_1}, x_{i_2}) \in E(D(G_1))$ and $f_1((x_{i_1}, x_{i_2}))(y_{j_1}) = y_{j_2}$, then $\{(x_{i_1}, y_{j_1}), (x_{i_2}, y_{j_2})\} \in E((G_1, f_1) \times (G_2, g_1))$, so $\{((x_{i_1}, y_{j_1}), z_{k_1}), ((x_{i_2}, y_{j_2}), z_{k_2})\}$ is in the matching between $\{((x_{i_1}, y_{j_1}), z_k)\}$ and $\{((x_{i_2}, y_{j_2}), z_k)\}$, with $k \in \{1, \dots, n_3\}$.

subcase 2. If $(y_{j_1}, y_{j_2}) \in E(D(G_2))$ and $g_1((y_{j_1}, y_{j_2}))(x_{i_1}) = x_{i_2}$, then $\{(x_{i_1}, y_{j_1}), (x_{i_2}, y_{j_2})\} \in E((G_1, f_1) \times (G_2, g_1))$, so $\{((x_{i_1}, y_{j_1}), z_{k_1}), ((x_{i_2}, y_{j_2}), z_{k_2})\}$ is in the matching between $\{((x_{i_1}, y_{j_1}), z_k)\}$ and $\{((x_{i_2}, y_{j_2}), z_k)\}$, with $k \in \{1, \dots, n_3\}$, which is enough to prove the theorem. \square

See that the associativity of the cartesian product of graphs [2, 14] is a consequence of the theorem 3.3 because if the bijections associated by the linking applications are always the identity, they satisfy the conditions of the theorem.

3.2 Invariants

In this section, we prove that the maximum degree of the product graph is the sum of the maximum degrees of the factor graphs, and we present conditions that ensure the connectedness of the product graph.

Theorem 3.4. [10] Let $G_1(V_1, E_1)$ and $G_2(V_2, E_2)$ be graphs that are functionally linked by applications $f_1 : E(D(G_1)) \rightarrow F(V_2)$ and $f_2 : E(D(G_2)) \rightarrow F(V_1)$. For every vertex (u, x) of the graph $G^*(V^*, E^*) = (G_1, f_1) \times (G_2, f_2)$, we have that

$$d_{G^*}(u, x) = d_{G_1}(u) + d_{G_2}(x).$$

Proof. For each $(u, x) \in V^*$, we call $E_{G^*}((u, x))$ the set of edges that are incident on that vertex in the graph G^* . The application $h_i : N_{G_1}(u) \rightarrow E_{G^*}((u, x))$ is constructed as follows. Let $h_1(v) = (v, y)(u, x)$, in which $y \in V_2$ is such that $f_1((u, v))(x) = y$, with $(u, v) \in E(D(G_1))$, in which y exists because $f_1((u, v))$ is bijective. On the other hand, h_1 is injective because if $v_1, v_2 \in N_{G_1}(u)$ and $v_1 \neq v_2$, then necessarily $(v_1, y_1)(u, x) \neq (v_2, y_2)(u, x)$ for any values of y_1 and y_2 . Similarly, we construct $h_2 : N_{G_2}(x) \rightarrow E_{G^*}(u, x)$. If an edge is incident in (u, x) in the graph G^* , then it has the form $(u, x)(v, y)$. Then, it exists $(u, v) \in E(D(G_1))$, such that $f_1((u, v))(x) = y$ or $(x, y) \in E(D(G_2))$ such that $f_2((x, y))(u) = v$. Due to construction h_1 and h_2 , we have that $h_1(N_{G_1}(u)) \cup h_2(N_{G_2}(v)) = E_{G^*}(u, x)$. Otherwise, if $(u, x)(v, y) \in h_1(N_{G_1}(u))$ and $(u, x)(v, y) \in h_2(N_{G_2}(v))$, then there are arcs $(u, v) \in E(D(G_1))$ and $(x, y) \in E(D(G_2))$ such that $f_1((u, v))(x) = y$ and $f_2((x, y))(u) = v$. This contradicts condition 3 of the definition of linking applications, so it holds that $h_1(N_{G_1}(u)) \cap h_2(N_{G_2}(v)) = \emptyset$.

Now, we can construct the bijection as follows:

$h : (N_{G_1}(u)) \cup (N_{G_2}(x)) \rightarrow E_{G^*}(u, v)$ defined by

$$h(a) = \begin{cases} h_1(a), & \text{if } a \in N_{G_1}(u), \\ h_2(a), & \text{if } a \in N_{G_2}(x). \end{cases}$$

This proves the theorem. \square

From the previous theorem, we immediately obtain the following corollary.

Corollary 3.4.1. Let $G_1(V_1, E_1)$ and $G_2(V_2, E_2)$ be graphs that are functionally linked by applications $f_1 : E(D(G_1)) \rightarrow F(V_2)$ and $f_2 : E(D(G_2)) \rightarrow F(V_1)$. Then, the graph $G^* = (G_1, f_1) \times (G_2, f_2)$ has maximum degree $\Delta(G^*) = \Delta(G_1) + \Delta(G_2)$.

In general, the functional product of connected graphs is not necessarily connected, as it is showing in the next proposition.

Proposition 3.1. Let $G_1(V_1, E_1)$ and $G_2(V_2, E_2)$ be bipartite graphs with partitions such that $V_1 = V_{11} \cup V_{12}$ and $V_2 = V_{21} \cup V_{22}$, with $|V_{11}| = |V_{12}|$ and $|V_{21}| = |V_{22}|$. Let $f_1 : E(D(G_1)) \rightarrow F(V_2)$ and $f_2 : E(D(G_2)) \rightarrow F(V_1)$ the respective linking applications, such that if $f_1(e)(u) = v$, then u and v are in different partitions of G_2 and if $f_2(e)(u) = v$, then u and v are in different partitions of G_1 . Then, the graph $G^*(V^*, E^*) = (G_1, f_1) \times (G_2, f_2)$ is disconnected.

Proof. Let $V_1 = \{0, 1, 2, \dots, n - 1\}$, and $V_2 = \{0, 1, 2, \dots, m - 1\}$, for $i = 0, 1, 2, \dots, n - 1$, and $j = 0, 1, 2, \dots, m - 1$. Without loss of generality, suppose that $V_{11} = \{0, 2, 4, \dots, n - 2\}$, $V_{12} = \{1, 3, 5, \dots, n - 1\}$, $V_{21} = \{0, 2, 4, \dots, m - 2\}$, and $V_{22} = \{1, 3, 5, \dots, m - 1\}$. Let $G^*(V^*, E^*) = (G_1, f_1) \times (G_2, f_2)$ be the functional product graph.

Let's prove that the edge $\{(i, j), (i', j')\} \in E^*$ if and only if $(i + j)$ and $(i' + j')$ have the same parity. By the definition of functional product, $\{(i, j), (i', j')\} \in E^*$ if and only if one of the following conditions is true:

1. $(i, i') \in E(D(G_1))$, and $f_2(j) = j'$ or $f_2^{-1}(j) = j'$;
2. $(j, j') \in E(D(G_2))$, and $f_1(i) = i'$ or $f_1^{-1}(i) = i'$.

In case 1, we have:

If i is even and j is even, then i' is odd and j' is odd.

If i is even and j is odd, then i' is odd and j' is even.

If i is odd and j is even, then i' is even and j' is odd.

If i is odd and j is odd, then i' is even and j' is even.

In all cases, the sum has the same parity.

In case 2, it is sufficient to proceed in a similar way to achieve the desired result. So, $G^*(V^*, E^*) = (G_1, f_1) \times (G_2, f_2)$ is disconnected and G^* has 2 connected components of the same cardinality. \square

The following theorem gives a condition that ensures the connectedness of a functional product graph if the factors are connected. We are going to need two new concepts, namely **centered applications** and **centroids**.

Definition 3.8. Let $G(V, E)$ be a graph, W be an arbitrary finite set, and $f : E(D(G)) \rightarrow F(W)$ be an application, it is said that f is **centered** if it exists $x \in W$, such that $f(e)(x) = x$ for all $e \in E$. Then, x is called a **centroid** of f .

Theorem 3.5. Given two graphs $G_1(V_1, E_1)$ and $G_2(V_2, E_2)$ that are connected and functionally linked by applications $f_1 : E(D(G_1)) \rightarrow F(V_2)$ and $f_2 : E(D(G_2)) \rightarrow F(V_1)$, if f_1 or f_2 is a centered application, then the functional product G_1 by G_2 , with respect to f_1 and f_2 , is connected.

Proof. Without loss of generality, suppose that f_2 is centered, and let $y \in E_1$ be the centroid of f_2 , $G^*(V^*, E^*) = (G_1, f_1) \times (G_2, f_2)$, and $V_2 = \{u_1, u_2, \dots, u_n\}$. Because y is the centroid and G_2 is connected, all vertices $(y, u_i) \in V^*$, such that $i \in \{1, \dots, n\}$ are in the same connected component of G^* . Now, let $(x, u_{i_0}) \in V^*$ be arbitrary, because G_1 is connected, there is a path $xx_1x_2 \dots x_p$, with $x_p = y$ linking x at y in G_1 . Let $u_{i_1} = f_2((x, x_1))(u_{i_0}) \dots u_{i_p} = f_2((x_{p-1}, x_p))(u_{i_{p-1}})$, then the path $(x, u_{i_0})(x_1, u_{i_1}) \dots (x_p, u_{i_p})$ joins the vertex (x, u_{i_0}) with (y, u_{i_p}) . This proves that all of the vertices of G^* are in the same connected component. Therefore, G^* is connected. \square

The cartesian product of graphs is connected if and only if both factors are connected. For more details, one can refer to [2, 14]. Note that this result is a consequence of the theorem 3.5 because, in the cartesian product of graphs, the linking applications of f_1 and f_2 assign the identity to all arcs of the corresponding digraphs, ie, both are centered applications.

4 Applications Functional Product of Graphs

In this section, we present some results that show how generate harmonic graphs from any regular graph. As consequence of theorem 4.2, the total coloring of those graphs is equitable and, in consequence, it satisfies the Wang's Conjecture. In order to better understand the following results, we first state two theorems, which appears in [21] and [11] respectively.

Definition 4.1. [11] A regular graph G is said to be **harmonic** if it admits a range coloring of order Δ (or equivalently a two-distant coloring) with $\Delta + 1$ colors.

Theorem 4.1 (Petersen, 1891). [21] If $G(V, E)$ is a $2k$ -regular graph, then G is two-factorizable.

Theorem 4.2. [11] Let $G(V, E)$ be a regular graph and $c : V \rightarrow C = \{1, 2, 3, \dots, \Delta + 1\}$ a range coloring of order Δ of G . Then, there is a equitable total coloring of G with at most $\Delta + 2$ colors.

Theorem 4.3. For any regular graph G and its complement G' , there are linking applications f_1 and f_2 , such that $G^* = (G, f_1) \times (G', f_2)$ is a harmonic graph.

Proof. First note that for any regular graph G , either $\Delta(G)$ or $\Delta(G')$ is even. In fact, if $\Delta(G)$ is odd, then because $n =$

$|V(G)|$ is even, $\Delta(K_n)$ is odd and $\Delta(K_n) = \Delta(G) + \Delta(G')$, it follows that $\Delta(G')$ is even. Initially suppose that $\Delta(G')$ is even, by Theorem 4.1, there is a decomposition of G' into two-factors. For each two-factors F , replace each cycle by an oriented cycle and define the application $a : V(F) \rightarrow V(F)$, such that if $(u, v) \in E(F)$, then $a(u) = v$ and, clearly a is a bijection.

The application f_2 associates the bijection a to each arc of the cycle and it associates the inverse bijection to each reverse oriented cycle. In the graph G , the application f_1 associates the identity to all pairs of arcs associated to edges. Now, if $V(G) = v_0, v_1, v_2, \dots, v_p$, then in each vertex of the form (x, v_p) , we apply the color p . By construction, the resulting coloring of $G^* = (G_1, f_1) \times (G_2, f_2)$ is a coloring with range Δ and it has $\Delta + 1$ colors. If $\Delta(G')$ is odd, then $\Delta(G)$ is even and so one only needs to change the positions of G and G' , in the previous reasoning, to obtain the desired result. Therefore, $G^* = (G, f_1) \times (G', f_2)$ is a harmonic graph. \square

Theorem 4.4. *Let G be a regular graph and G' be its complement. If $\Delta(G')$ is even, then for any graph H such that $\Delta(G') = \Delta(H)$ there are linking applications f_1 and f_2 , such that $G^* = (G, f_1) \times (H, f_2)$ is a harmonic graph.*

Proof. It is only necessary to note that both G' and H can be decomposed in the same number of two-factors and each two-factor of G' has an associated bijection of vertices of G . Let $F_1, F_2, F_3, \dots, F_t$ be the two-factors of the decomposition of G' , let r_1, r_2, \dots, r_t be the associated bijections, and let $K_1, K_2, K_3, \dots, K_t$ be the two-factors of the decomposition of H , which will be replaced by oriented cycles O_1, O_2, \dots, O_t , the application of f_2 associates the bijections r_i to each arc O_i , and r_i^{-1} to the reverse oriented cycle for all $i \in 1, 2, \dots, t$. The application of f_1 associates the identity to all edges of G . Now, if $V(G) = v_1, v_2, \dots, v_p$, then in each vertex of the form (x, v_p) , we apply the color p . Then, by construction, the resulting coloring of $G^* = (G_1, f_1) \times (G_2, f_2)$ is a coloring with range Δ and it has $\Delta + 1$ colors. Therefore, the graph is harmonic. \square

Figures 6, 7, 8, and 9 illustrate the proof of Theorem 4.3 using a 3-regular graph with eight vertices. Figures 10, 11, 12 and 13 illustrate the proof of Theorem 4.4 using two cycles, C_5 and C_3 . Figure 14 shows the equitable total coloring of the harmonic graph, obtained as a consequence of theorem 4.2.

Figures 10, 11, 12 and 13 illustrate the proof of Theorem 4.4 using two cycles, C_5 and C_3 . Figure 14 shows the equitable total coloring of the harmonic graph, obtained as a consequence of theorem 4.2.

5 Conclusions

This paper presented the functional product of graph, which is a generalization of the cartesian product of graphs. We show that the functional product is commutative, it has a neutral element, and associative under certain conditions. We prove a result that offers a characterization of the product graphs, ie. it shows how are graphs that can be obtained by the functional product.

We studied some invariants. Initially, we proved that the maximum degree of the product graph is the sum of the maximum degrees of the factor graphs. In relation to connectedness, we showed that the functional product of connected graphs is not necessarily connected. We proved a result that gives some conditions in which the functional product of connected graphs is disconnected. In addition, we presented a condition that ensures the connectedness of a functional product graph if the factors are connected.

On the other hand, the functional product has proved to be efficient at constructing graphs that "inherit" desirable properties from the factors as was shown in Section 4. As application of the functional product, we proved two theorems that ensure that harmonic graphs can be constructed using the functional product of graphs and any regular graphs as basis.

In future work, it will be studied the behavior of other invariants of graphs, for example chromatic number, connectivity, dominance, and diameter. In addition, it will be studied the possibility of recognizing families or subfamilies of graphs that can be obtained by the functional product. For example, the figures below 15 and 16 illustrate the **Kneser graph** $KG_{5,2}$ isomorphic to the **Petersen Graph** generated by the functional product of a P_2 and a C_5 .

References

- [1] Banič I & Žerovnik, J. 2008. The fault-diameter of Cartesian products. *Advances in Applied Mathematics*, **40**(1): 98–106.
- [2] Behzad M. (1965). Graphs and their chromatic number. Ph.D. Thesis. Michigan, USA.
- [3] Bondy J & Murty U 1976. *Graph Theory with Applications*, New York: North-Holland.
- [4] Broesma H. (2003). *A general framework for coloring problems: old results, new results, and open problems*, IJCCGGT, Springer 65–79.
- [5] Friedmann C. V. P, Lozano A. R. G, Markenon L, & Waga C. F. E. M. 2011. Total coloring of Block-cactus graphs *The journal of combinatorial mathematics and combinatorial computing*, **78**: 273–283.

- [6] Imrich W, Klavzar S, & Rall D. 2008. *Topics in Graph Theory: Graphs and their Cartesian Products*, Wellesley: Massachusetts, A K Peters Ltd.
- [7] Kemnitz A & Marangio M. 2003. Total Colorings of Cartesian Products of Graphs *Congres. Numer.*, **165**: 99–109.
- [8] Li N & Hou X. 2009. On the total $\{k\}$ -domination number of Cartesian products of graphs, *Journal of combinatorial optimization*, **18**(2): 173–178.
- [9] Lozano A. R. G, Friedmann C. V. P, Waga C. F. E. M, & Markenzon L. 2009. Coloração de Vértices com Folga, *Anais do Simpósio Brasileiro de Pesquisa Operacional (XLI SBPO)*, Porto Seguro, Bahia, Brasil, 3084–3091.
- [10] Lozano A. R. G, Siqueira A. S, Jurkiewicz, S, & Friedmann C. V. P. 2013. Produto Funcional de Grafos *TEMA - Tend. Mat. Apl. Comput.*, **14**: 221–232.
- [11] Lozano A. R. G, Siqueira A. S, Friedmann C. V. P, & Jurkiewicz, S. 2016. Relationship between equitable total coloring and range coloring in some regular graphs *Pesquisa Operacional*, **28**: 161–171.
- [12] Marcu D. 1996. On colouring products of graphs, *Mathematica Bohemica*, **121**(1): 69–71.
- [13] Rosenfeld M & Barnette D. 1973. Hamiltonian circuits in certain prisms, *Discrete Mathematics*, **5**(4): 389–394.
- [14] Sabidussi G. 1960. Graph multiplication, *Math. Z.*, **72**: 446–457.
- [15] Seoud, M. A. 1992. Total chromatic numbers, *Applied mathematics letters*, **5**(6): 37–39
- [16] Seoud, M. A, Abd el Maqoud A. E. I, Wilson R. J & Williams J. 1997. Total colourings of Cartesian products, *International Journal of Mathematical Education in Science and Technology*, **28**(4): 481–487
- [17] Spacapan S. 2008. Connectivity of Cartesian Products Graphs, *Applied Mathematics Letters*, **21**: 682–685.
- [18] Vizing V. G. 1963. The Cartesian product of graphs, *Vyc. Systemy*, **9**: 30–43.
- [19] Vizing V. G. 1964. On an estimate of the chromatic class of a p-graph, *Metody Diskret*, **3**: 25–30.
- [20] Wang W. F. 2002. Equitable Total Coloring of Graphs with Maximum Degree 3, *Graphs and Combinatorics*, **18**: 677–685.
- [21] Yap H. 1996. *Total colorings of graphs*, Berlin, Springer.
- [22] Yixian Y, Huangping L, Fangchun Y. & et al. 1999. Total chromatic numbers of product graphs, *Mathematica Applicata*, **2**: 1–21.
- [23] Zmazek B & Zerovnik J. 2002. Behzad-Vizing conjecture and Cartesian-product graphs, *Applied mathematics letters*, **15** 6: 781–784.

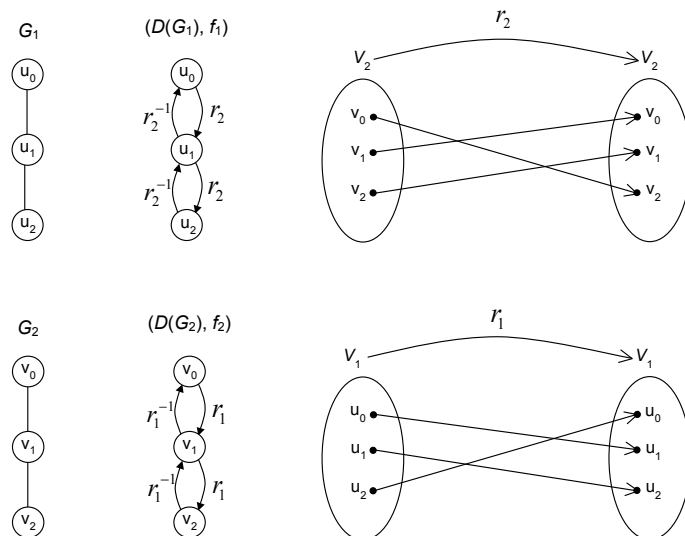


Figure 1: Graphs G_1 and G_2 , respective digraphs $D(G_1)$ and $D(G_2)$, and applications f_1 and f_2 .

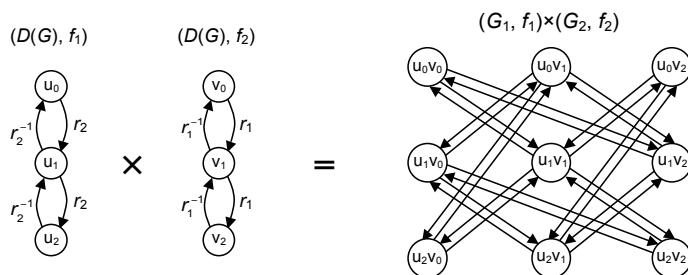


Figure 2: Functional Product between the Digraphs $D(G_1)$ and $D(G_2)$ according to f_1 and f_2 .

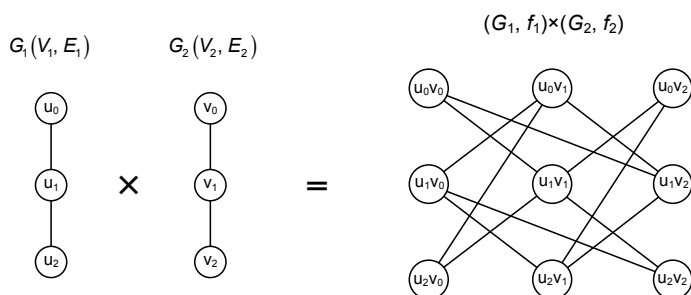


Figure 3: Functional Product between the graphs G_1 and G_2 according to f_1 and f_2 .

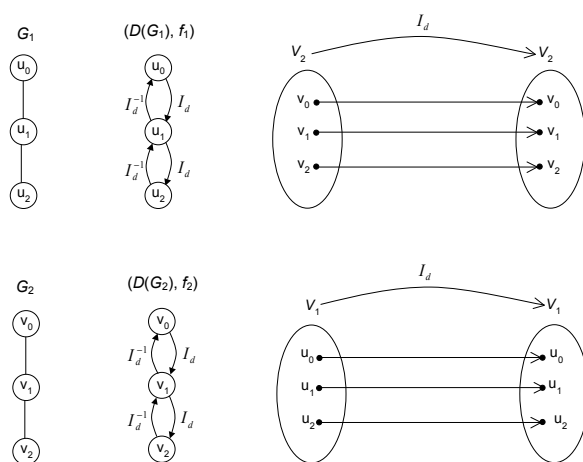


Figure 4: Graphs G_1 and G_2 , their respective digraphs, and applications f_1 and f_2 .

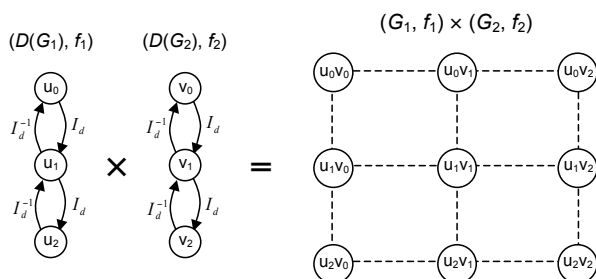


Figure 5: Functional Product (or Cartesian) between the graphs G_1 and G_2 according to f_1 and f_2 .

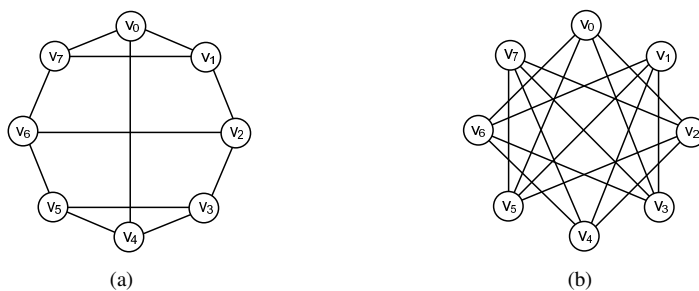


Figure 6: 3-regular graph and its complement.

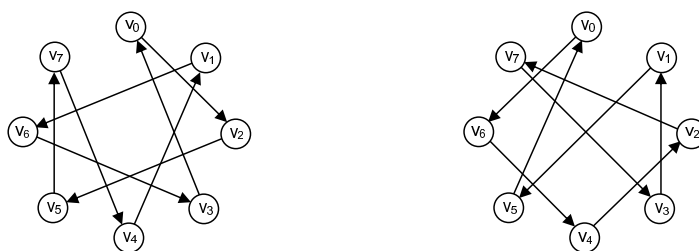


Figure 7: Cycles obtained from the decomposition of two-factors from the graph in Figure 6(b) with an arbitrary orientation.

0 → 2	0 → 6
1 → 6	1 → 5
2 → 5	2 → 7
3 → 0	3 → 1
4 → 1	4 → 2
5 → 7	5 → 0
6 → 3	6 → 4
7 → 4	7 → 3

Figure 8: Bijections associated with the cycles of Figure 7.

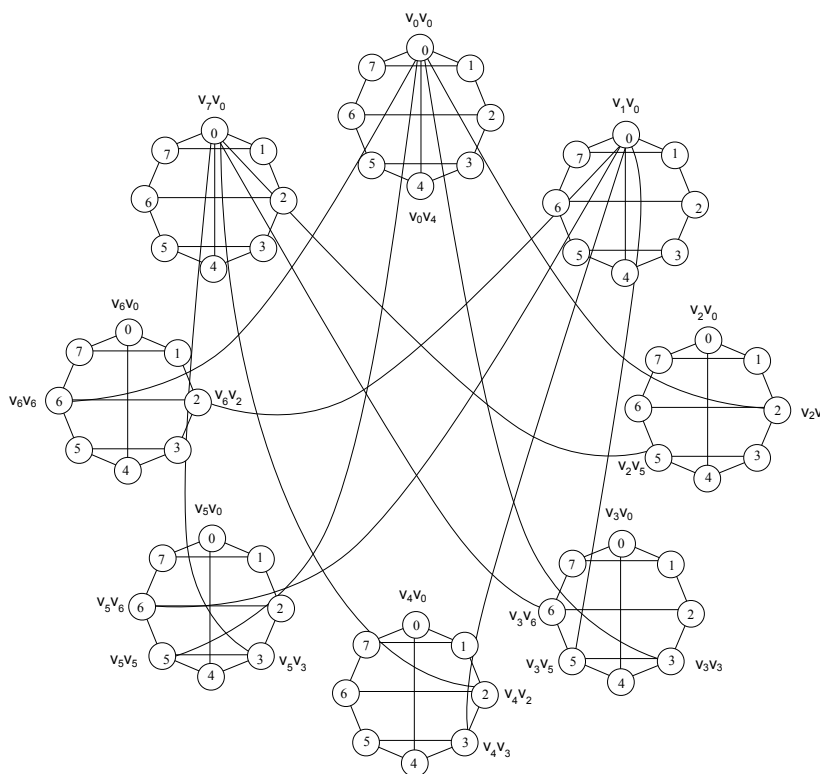


Figure 9: The start of the construction process of harmonic graphs, only the connections of the vertex (v_0, v_0) , (v_1, v_0) and (v_7, v_0) have been designed.

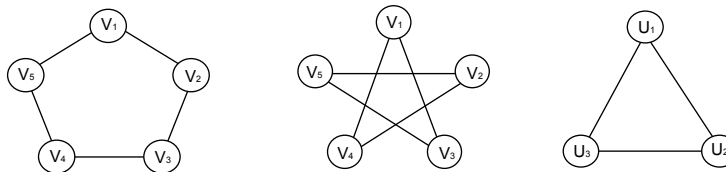


Figure 10: Graph $G (C_5)$, its complement G' , and graph $H (C_3)$.

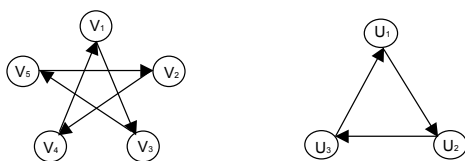


Figure 11: Cycle obtained from the decomposition of two-factors from the graph G' with an arbitrary orientation.

- 1 → 3
- 2 → 4
- 3 → 5
- 4 → 1
- 5 → 2

Figure 12: Bijection associated with the cycle of Figure 11.

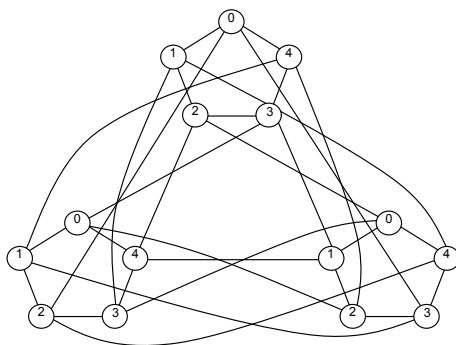


Figure 13: Range coloring of order 4 with 5 colors of the Harmonic Graph.

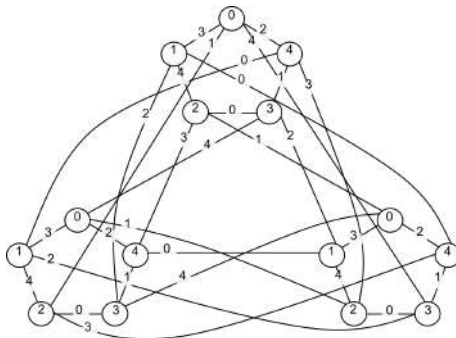


Figure 14: Equitable total coloring with 5 colors of the Harmonic Graph.

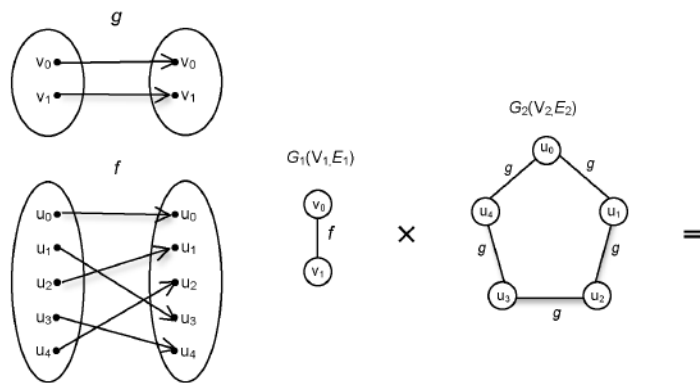


Figure 15: Graphs P_2 and C_5 with their associated bijections f and g .

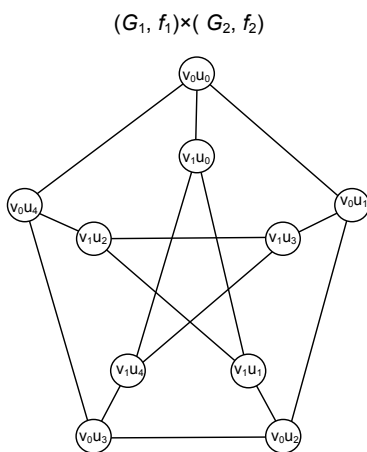


Figure 16: Petersen Graph generated by the functional product of a P_2 and a C_5 according to f_1 and f_2 .

The tracks of agony and pain in imprisonment: sinuous pathways of writing

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Abstract— *In this paper, we aim at analyzing the writing of subjectivity by means of the construction of memory from the circumscription of a place: jail. In this way, we are working with the book entitled Memórias do Cárcere, written by Graciliano Ramos, and we intend, through the investigation of certain traces evidenced in some passages, to understand to what extent the writing considered as a form of testimony of the author portrays the suffering referred to experience of custody in a prison institution. We concluded that the journey by the writing of these pages has an address and the author directly or indirectly wanted to share his bitter experience with those interested in knowing about it.*

Keywords— *Memory, Prison, Subjectivity, Violence, Writing.*

I. INTRODUCTION

The prison institutions, since the earliest times in the history of mankind, can be considered complex and somber places which, although placed on the margins of society, are part of it. When we talk about these institutions, we automatically link them to crime and the person arrested, the two pillars that give support to the prison. These institutions represent the production of a kind of solution idealized by a social class whose immediate destination would be those who disobey the rules created by the ruling class. In a sense, they are the reflection of the impotence, in the scope of the human experience, to equate injustices; not by means of an equivalence of a way of living but by the submission of a human being to the apparatuses of the State occupied and represented by its humans.

Possibly, a consequence of the social structure in terms of the organization of society was the establishment of the principles and norms to be followed as the fundamental guarantee of the condition of survival and respect. That is to say, for human beings, to live in the system of social bonds, it is necessary for them to assimilate norms and behave according to the prescriptions contained therein. In order to ensure respect for the rules, punitive mechanisms were established for those who opposed or even infringed upon them. These rules vary from nature and historical contexts,

consequently providing their own configurations in the interpretation of an action as criminal or not.

It is not the purpose of this paper to deepen the history of prisons - there are already several treaties regarding this topic, such as *History of Prisons in Brazil* (MAIA et al, 2009), since we will focus only on the specific context of the imprisonment of a Brazilian man, Graciliano Ramos, condemned for thinking differently from the current political system and who, pressed by the memories that stir up suffering, left in his tracks a writing which depicts a crossing in prison. Even though the author of this writing has portrayed the role of writer, we can not fail to consider a particularity: these are grafts of memories produced as a function of an experience of prison confinement. It is this singularity that must be evidenced in the construction of the book, from the beginning to the end, that is, if we can speak of the beginning and end of a book of such density and complexity.

Thus, the author conceives one of his greatest works, *Memórias do Cárcere*, which, even posthumously, portrays the history of subjective sequels of a being who, having been imprisoned by an imposition of the State, leaves tormenting memories recorded which remain even after the liberation of the prison walls. In a certain way, when a prisoner is released from prison, his psychic universe remains for a long time confined to the

institution, because the prison has a kind of stickiness that adheres to the person, forever. That is, Graciliano used writing as a way of trying to untie the indestructible vestiges that the prison left to him, as a way to get rid of the terrible memories. Writing, then, represents, among other senses, a kind of elaboration that allows the being to distance itself from that experience, as far as possible. According to Farias et al. (2014), "violence produces a (...) kind of rupture that consists in the production of (...) vestiges and impressions, which may, depending on certain circumstances, be transformed into memory".

In this way, the present article aims at analyzing writing as a means of memory production related to prison, as well as understanding the story of the narrator. We are reminded of the uniqueness of Graciliano's writing about this place since, subjectively, he never considered him as a criminal, so for him his reclusion was a misunderstanding and a reflection of an authoritarian system. What Graciliano portrays about the prison in his writings has to do with a vision of imprisonment due to injustice, evidenced in the act of his incarceration. In this sense, writing can be a form of resistance, a denunciation of injustice, as well as, by sharing lived experiences, a form to alleviate suffering. Also, we consider jail as a place of production of memory in terms of the dynamics and social actors present in this place that create, then, a dynamism whose results are the memories, even if fragmentaed and silenced.

Bearing in mind that the text must be considered within the historical and political contexts of the time it was written, and mainly because of its agent, the life course of the prisoner, imprisoned, in his conception, unjustly, the present study becomes relevant because existing studies on the subject are constructed only under historical or literary lenses. Our focus, on the other hand, is to cast a glance with another lens, that of prison since it seems to be common practice, in the Brazilian imaginary, the conception that arresting is the solution for criminal actions. However, this logic is not a Brazilian creation, but rather the reproduction of secular procedures of torture, punishment and deprivation of liberty. Like many other modes of action, Brazil inherited from its colonizers the idea that the solution to certain situations is the imprisonment with restriction and deprivation of liberty.

The method of analysis will consist in taking the writer's writing about the daily life in prison, which in his memories enabled us to know certain nuances, hitherto invisible, in order to make clear the footprints that marked a trajectory due to his nonconformity, resistance and denunciation in being forced to confinement by his ideals and his way of thinking. Among the methodological

elements to be considered in the approach to the work, we will follow Ginzburg (2013), when he highlights two crucial elements for the study of narratives: narrator analysis and historical contextualization.

From the narrator's point of view, we are before a writer who has created characters in scenarios considered not only controversial, but pernicious to the political *status quo* of the country at a time when an authoritarian and coercive regime prevailed. In a way, Graciliano Ramos was considered an author *a la gauche*, which is why he should be promptly silenced and demoted as a citizen, for a "crime" in relation to which he was not even sentenced.

Concerning the historical contextualization, we will examine which hegemonic discourses in the period in question, the Era Vargas, in relation to the conditions of production of the book since, according to Ginzburg (2013, p.35), "violence is built on time and space" and the analysis must take into account the relations between the social actors and the processes present at the time.

Thus, based on a qualitative approach, we will proceed in a decontextualization of the book's memorial fragments to be analyzed in order to produce an understanding of the life of a human being in prison. It is these strategies of action through which we turn to produce a meaning among the possible multiples on the crossing of who, for many nights, witnessed the living in prison.

In this way, we are led to wonder what it means to write in the face of the pressure of agonizing memories that rekindle and incessantly actualize the experience of the prison in a kind of past that, paradoxically, do not pass.

II. ERA VARGAS: THE BEGINNING OF GLOOMY TIMES

From the authoritarian regime of 1930, the so-called Era Vargas began in Brazil, whose proposal was to annihilate the political and social issues inherited from the previous period. However, this dictatorial period was structured in three moments: Provisional Government, Constitutional Government and what they called *Estado Novo*. In the first moment, the concern was to revive the coffee industry, devalued in the crisis of 1929, while the Constitutional Government was busy organizing a new constituent for the country. The *Estado Novo* began in 1937, as the presidential campaign for the elections that would occur the following year and its main focus was on the economic policy, seeking to develop industries and companies in the country.

The cultural production in the country during the Era Vargas was quite abundant. According to Sodré (2004, p.627), “the phase of freedom, which is always naturally relative, inaugurated in the late 1930s, is closed at the end of 1935, when a phase of political repression begins”. That is to say, while the State was supposed to care for the rights of the citizens, an authoritarian and controlling policy was created that sought to limit society by depriving its ideas, that is, censorship, as well as deprivation of their liberty, with unfounded prisons, torture, exile, deportation and even death.

During this government, several Brazilian writers suffered reflexes of the Estado Novo dictatorial system, among them, Graciliano Ramos. His penury began in 1936 when, after refusing the “suggestion” to resign from the public office where he used to work on, he was arrested at his home, without any formal accusation by the State, remaining imprisoned for ten months and going through all types of misfortunes, until he was acquitted and released in 1937 for lack of evidence to support his involvement with communism. In that sense, we would like to ask: whom bothered Graciliano Ramos' ideas to the point of judging the power of his writing to be an uncontrollable weapon? Nevertheless, it is pertinent to point out that the deprivation of the right to come and go of a human being does not harden its spirit, as evidenced by the writings produced in prison by Graciliano and that continued until the death of that mind that took the sleep of those who feared that their ideas were widespread and understood.

Then, we would like to propose a reflection on the reasons why prison is understood as a space of deterioration of the human being. As we have already mentioned, we do not intend to delve into the history of prisons, because several authors have already set out to compose a detailed history on the subject. In fact, we seek to focus on imprisonment, in Foucault's conception (2008, p. 195), as “the general form of apparatus for making individuals docile and useful by means of precise work on their body” a device that is capable of curtailing rights and controlling acts such as eating, drinking, sleeping, in short, as a structure capable of demonstrating vilely what would be a social place of belonging, but in a depressed and demeaning way by humiliation. In addition to Foucault, Tuan (2005) demonstrated the relations of power that allow to delimit the place of each human being in society, that is, if the human being becomes a danger, as the vision of the Vargas government in relation to Graciliano Ramos, he must be removed from society so that it does not contaminate it. So we ask: is the human being who becomes a danger or are his ideas? No doubt the placid masters of power feel tormented by ideas and

as they can not destroy them, they punish their creator, in the vain hope that he will not produce something of this kind anymore.

On the basis of the above, we begin the construction of the analysis of fragments in relation to the subjectivity, captured in a writing whose main content is suffering allied with the feeling of injustice, always taking into account the inseparable relationship between experience and narration, and also the fact that “we call experience what can be put into account, something lived that not only is suffered but is transmitted. There is experience when the victim becomes a witness (SARLO, 2007, p.26)”. Thus, the practice in question has as its determinant to understand the justifications attributed to this experience, the circumstances related to imprisonment due to a political ideology and the internal pressures that mobilized the writer to narrate, as the author, his own crossing.

The book *Memórias do Cárcere* will be considered a dossier related to the innumerable passages marked by the circumstance in the prison, being configured a scene in which three acts slide: in the first, Graciliano Ramos occupies the position of actor, being at the same time, character. In the second, it appears as an agent of production of a writing which reveals in the recesses the pain and suffering of an experience of incarceration. And finally, in the third, it proves to be a living witness of a difficult crossing. It is important to point out, however, that the literature of testimony, as is the case of the book in question, is a nuance of the field of literature and in this way, causes the whole history of literature to be revised from the questioning of its commitment to the real. Still, one must take into account the distinction between “real” and “reality” as was thought by the realist and naturalistic schools. On the other hand, the “real that interests us here must be understood by the Freudian key to trauma, of an event that justly resists to representation” (SELIGMANN-SILVA, 2003, p. 377).

III. MEMÓRIAS DO CÁRCERE: NARRATIVES OF AN IMPRISONED SOUL

As we take a brief look at the Graciliano Ramos' books, we notice that the most part of them are literary constructions, provided with characters, scenarios and fictional entanglements with beginning, middle and end, meticulously constructed by the mind of Graciliano. In what concerns *Memórias do Cárcere*, we do not have a story, but memories of the author, that, flooded by the suffering, has the prison as the scenario; that is, it is not a fictional story, but a story of a life that transpired between the lines of his writing.

The book is divided in four volumes, being: Travel, Primary Pavilion, Correctional Colony and House of Correction. In the first volume Graciliano narrates his trajectory from the threats he received as a public official of the State of Alagoas until the beginning of his imprisonment in the officers quarters, when later he was transferred aboard the ship Manaus, moments in which Graciliano describes with promptness all the dirt and the neglect with which they were treated: according to his own words, he was in “a pigsty, of course, it was as if we were animals” (RAMOS, 2011, p. 167).¹

In the second volume of the book Graciliano reports his arrival in the city of Rio de Janeiro, he denounces the terrible meals that were offered to them, describes the innumerable people he had met in prison, even though the atmosphere around them was that of violence and oppression, as well as he narrates the fusion of feelings that plagues him when he becomes aware that his wife will visit him.

In the third volume of his memoir, Graciliano brings us the scene of Dois Rios prison, on Ilha Grande, and his affliction for the change, since it was a place known for the precariousness and mistreatment of prisoners, evidenced by the discourse of a sergeant: “There are no rights here. Listen. No rights. Who was a great man, forget about it” (RAMOS, 2011, p. 69). In addition to the psychological torture, Ramos denounces the physical torture and inhuman treatment they were given when he had to choose between starving himself or eating rodent-infected food, which caused them severe pain. By trying to resist such inhumane treatment, Graciliano's physical body is gradually calling for help, so he is transferred to the detention house.

Finally, in the last volume, the author finishes his thoughts by telling us about the perceptions about himself, how he was physically weakened, and came to the conclusion that in fact this had been the intention of the government from the beginning, because in that way they would not be able to react to the state impositions.

Having detailed the structure in which the memories are available, we can make some considerations. There is in the book an author who is both narrator and character while the plot is his life. Because it is a memorial book,

we can observe aspects of the past based on facts that occurred in Graciliano's life, so that the author felt unconcerned in: “[...] walk left and right, jump in uninteresting passages, stroll, run, return to known places. I shall omit essential events or I will mention them at a glance, as if I see them through the small glasses of a binoculars, I will magnify insignificances, I will repeat them until I am tired, if that seems convenient to me” (RAMOS, 2011, 14).

When we consider Graciliano's writing not only as a memoir but also as a form of denunciation and resistance to the injustices for which he was being subjected, we note that Graciliano not even underwent a law process: “They showed no sign of submitting us to trial. And it was possible that they had already judged and served us punishment and we did not know anything about it. All rights, the last vestiges of them, were thus suppressed. We did not even know the forum that sentenced us” (RAMOS, 2011, p.102).

Still, we can see that Graciliano leaves traces of tormenting memories that annoy him because they allow, even after releasing the limits of the prison, that the person remains subjectively trapped in his memories: “Will this depersonalization be necessary? After submitted to such a regime, an individual is acquitted and sent away. Little is served by his acquittal: as being used to move as if he were drawn by twine, he will hardly be free” (RAMOS, 2011, p. 43), that is, although the author does not make use of the first person in the singular, and does “juggling to avoid it” - we recognize the denunciation of a pain that will never be released.

During the period in which he was imprisoned Graciliano sought, through writing, to reconstruct all the torment lived as a way of resisting in his uniqueness of human being, for when being arrested, regardless of whether committed crime or action considered criminal, once condemned every human being is equal, becoming a homogeneous class (FOUCAULT, 2008), fact evidenced in the speech of the sergeant of the prison of Dois Rios: “There are no big ones here. You are all the same” (RAMOS, 2011, 69). In this sense, memory and memory reports, according to Sarlo (2007), would be a “cure” of objectification, of depersonalization during the incarceration time.

Besides all the feelings of anguish and sadness, Graciliano so masterfully makes us understand his confused feelings, which translate into words, his most valuable tools, as a way to be expelled from his spirit: “[...] I felt stunned, as if I were punched in the head. I considered myself the author of several faults, but I did not know how to determine them. I vaguely repented of

¹ The passages from the book *Memórias do Cárcere* were translated from portuguese to english by the authors of this paper since the book was not translated to any other language.

harshness and injustice, at the same time supposed myself weak, slipping in useless condescension, and I wanted to stiffen my heart, to eliminate the past, to do with it what I do when I set a period - to scratch, to thicken the risks and transform them into blurs, suppress all letters, leave no trace of obliterated ideas” (RAMOS, 2011, p.35).

And once again he denounces the atrocity he experienced, when he said that “this blossoming of evil feelings was the worst torture we could inflict on that terrible year” (RAMOS, 2011, p 15).

During the months in which he was confined, he had for several times to discard his manuscripts as he was transferred from one prison unit to another, so he only began recording his experience and decided to narrate it ten years after his freedom; which for Benjamin (1994, p. 204) it is not a problem at all: “A story is different. It does not expend itself. It preserves and concentrates its strength and is capable of releasing it even after a long time”. Thus, Graciliano gives us a clear indication that this singular work was about the truth of the elaboration of the trauma that he experienced. Erasing and writing are the testimonies of the desire of someone who made the choice for life in a kind of crossing compared to the destiny determined by Hades, portrayed by Virgil: “Flectere si nequeo superos, Acheronta Movebo”. It is as if Graciliano Ramos reflected that in the impossibility of moving authoritarianism, he tried to move what was within his reach with his writing: he demonstrated injustice by his imprisonment. This is the purpose of his writing: to illuminate the trajectory of clumsy human beings who were threatened by his ideas.

“- I have excellent memories, doctor. And I will pay for the hospitality that you have given me.

-Pay how? (...)

Telling everybody what happens on Ilha Grande (...) Yes, doctor, writing. I put it all on paper.

The deputy director stepped back, opened his eyes, and asked, frowning,

-Are you a journalist?

- No, sir. I write books. I'll make one over the Correctional Colony. Two hundred pages or more. You gave me a magnificent subject. A curious story, no doubt.

The doctor buried his hard eyes, his sharp face full of shadows. He turned his back on me and went away grumbling:

Those horses²...It's their fault that they send us people who know how to write” (RAMOS, 2001, p. 516).

In this way, his narrative was reconstructed by the memory images and memories that he possessed, as a form of elaboration since “to propose not to remember is similar to propose not to perceive a smell, because the memory, as well as the smell, affects, even when it is not evoked” (SARLO, 2007, p.10). Although he had built such a masterpiece, he was not able to finish it, having it been published posthumously, honoring the book title with the word “memories”.

When we consider jail as a place of memory, in Nora's conception (1993, p. 13), we note that the book “is born and lives from the sense that there is no spontaneous memory, that we must deliberately create archives, (...) because such activities no longer occur naturally. (...) Indeed, it is this very push and pull that produces lieux de memoire-moments of history torn away from the movement of history, then returned” in some way through writing.

We can conjecture, then, that the book *Memórias do Cárcere* gives us, through reading, the contemplation of the suffering and violence suffered by the collective memory of the individuals who were part of this narrative, since, according to Halbwachs (2006, p. 39), “our memories remain collective and are remembered to us by others”. That is, collective memory is a structured and structuring foundation of social relations, and therefore, we never remember outside the context of social relations. Thus, it is in and through society that men construct memories.

Finally, in the process of writing these memoirs, Graciliano Ramos died. And curiously, the author dies when he was almost finishing his writings, even though at the beginning of the book he has already warned us: “I am going down to the grave, this ball of cases in many points will get entangled, I write with slowness” (RAMOS, 2011, p. 13). According to his son, the person responsible for the publication of the book: “he did not try to complete his Memories of the Prison” (RAMOS, 2011, p. 318). And then we realize that he has not tried to complete his memories because he can not “complete” or break free from his pain.

IV. CONCLUDING REMARKS

The present article had the objective of analyzing writing as memory production related to jail in the book *Memórias do Cárcere* written by Graciliano Ramos,

² It is a way of cursing and offending someone.

taking into account approaches about the historical context in which the author was inserted, that is, the Era Vargas, a crucial fact to the understanding of the story, as well as he reports the torture and violence suffered in the prison units for which he was forced to pass.

In the construction of his memoir, we find a subject who needs to narrate his experiences and events as a way of elaborating the suffering and the pernicious feelings that affected him. In this sense, the narrator Graciliano Ramos incorporates into the history of Brazilian literature the figure of a reflective, nonconformist, resistant and denunciatory human being, in telling experiences of violence and barbarism. This narrator, in turn, feels the need to share his experiences by building a dialogue with the reader, which in turn must play its part in becoming active.

Although he made it clear in his writings that he disliked and thus endeavored not to use the first person of the singular, and thus did not exceed his “ordinary size”, Graciliano left us as his heritage a work that not only brings a critical vision of the events that occurred at the time, as it is a subjective testimony of a human being who had to leave all his pain registered as an attempt to escape it, since the more he tried to move it away, the closer he felt to it. Was it not the realization of this impossibility that prevented him from completing the work, since the memory caused by pain became inevitable?

Based on the above, we conclude with the reflection that Graciliano Ramos lived to write works such as *São Bernardo* (Saint Bernard), *Vidas Secas* (Barren Lives) and *Angústia* (Anguish), but he wrote *Memórias do Cárcere* to live and portray the hardships of a human being who was arbitrarily and unjustly imprisoned.

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REFERENCES

- [1] B. Sarlo, “Tempo passado, cultura da memória e guinada subjetiva” (2007), São Paulo: Companhia das Letras.
- [2] C. N. Maia et al (org), “História das prisões no Brasil” (2009), Rio de Janeiro: Rocco.
- [3] F. Farias, “Quatro questionamentos sobre a violência” (2014). Rio de Janeiro: Contra Capa.
- [4] G. Ramos, “Memórias do Cárcere” (2011), Rio de Janeiro: Record.
- [5] J. Ginzburg, “Literatura, violência e melancolia” (2013). São Paulo: Autores Associados.
- [6] M. Foucault, “Vigiar e punir: nascimento da prisão” (2008). Petrópolis: Vozes.

- [7] M. Halbwachs, “Memória individual e coletiva” (2006), São Paulo: Centauro.
- [8] M. Seligmann-silva, “O testemunho: entre a ficção e o real” (2003), In: ____ (Org.). História, Memória, Literatura. Campinas: Unicamp.
- [9] N.W. Sodré, “ História da literatura brasileira” (2004), Rio de Janeiro: Graphia.
- [10] P. Nora, “Entre Memória e História: a problemática dos lugares” (1993), Projeto História, São Paulo, n.10. dez.
- [11] R. Ramos, “Graciliano: retrato fragmentado” (2011), São Paulo: Globo.
- [12] Vergílio, “Encida” (1981), Tradução de Carlos Alberto Nunes. São Paulo: A Montanha.
- [13] W. Benjamin, “O Narrador” (1994). In: Walter Benjamin. Obras escolhidas I. Magia e Técnica, Arte e Política. São Paulo: Brasiliense.
- [14] Y.F.Tuan, “Paisagens do medo” (2005), São Paulo: UNESP.

Descriptive Anatomy of Masseter Muscle in Maned Wolf (*Chrysocyon Brachyurus* - ILLIGER, 1815)

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Abstract— *The present study is a descriptive and comparative research of masseter muscle in Maned Wolf, involving dissection, analysis and discussion with domestic dog, relatively, well established. For this, two adult specimens, with no defined age, were used under usual techniques of preparation and dissection in anatomy. In this sense, this work shows that masseter muscle in Maned Wolf is rectangular oblique, dorsal to ventral and rostral to caudal, on lateral side of head and ventrally to the ear, extending from ventral border of zygomatic arch to mandible. In summary, the results reveal that there is a basic anatomical pattern similar to domestic Dog, differentiating its rectangular shape and number of layers. However, this study showed unprecedented characteristic and differences inherent to each species, especially those related to their size and eating habits.*

Keywords— *Wild Animals, Masticatory Muscles, Dissection and Cerrado Biome.*

I. INTRODUCTION

Maned Wolf (*Chrysocyon brachyurus* - ILLIGER, 1815) belongs Chordata phylum, Carnivorous order, Mamalia class and Canidae family, weighs between 20 and 23 kg, between 145 and 190 cm in length and approximately 80 cm in height. This animal has solitary habit, approaching another animal of the same species in times of reproduction. Their food habit is omnivorous, but preferentially feed fruits, reptiles, insects, small vertebrates and eventually large vertebrates [1,2,3].

Its habitat comprises, mainly, Cerrado, considered a mosaic of phytophysiognomies, due its varied characteristics, including forest, savanna and country [4,5,6], and also found in other areas, such as eastern slope of Serra do Espinhaço (MG), Serra da Mantiqueira, in the south and in the states of Rio de Janeiro, São Paulo and Minas Gerais [1,3]. The survival of this species is significantly threatened by loss of habitat for agricultural

activities, motivated by food competition or disease transmission [1,6].

The understanding of its biological system and correlation with components of biome that it is inserted is essential information for its conservation, which can be evidenced in comparative anatomical study. Is relevant consider that anatomy is the science that studies structural composition of living beings, and it is possible to observe eventual morphofunctional alterations in phylogenetically close taxonomic groups, associated with behavior and adaptations of food, reproduction and survival in environments that no longer retain their originality, in face of unavoidable human intervention [7,8,9].

Masticatory effectiveness of mammals is fundamental for their survival, considering that main role is essential in their feeding, so anatomical study of mastication muscles, especially Masseter muscle in Lobo-Guará, becomes relevant, since could be evidenced that this

muscular group develops from muscular action allied to mechanics of skull, besides mastication muscles adaptations, according to dental morphology. Thus, each species may present anatomical differences, considering that masticatory pattern of each species is different [14] [10,11].

Anatomical, topographical and/or systemic descriptions of species are fundamental for biological system knowledge and veterinary clinical practice [12]. However, in view of great importance of wild animal's anatomy for biome eco-sustainability, the anatomy of Maned Wolf is little studied. Considering that muscular system is related to important functions, such locomotion and animal feeding, studies related to this subject are of great value. Therefore the objective of this work was to investigate and describe the anatomy of Masseter Muscle in Maned Wolf (*Chrysocyon brachyurus* - ILLIGER, 1815), as a literary subsidy for different areas of knowledge.

II. MATERIAL AND METHODS

The present paper is a descriptive and comparative anatomical study with one male and one female specimen of Lobo-Guará (*Chrysocyonbrachyurus*), obtained from accidental death on the roadsides of Brazilian Southeast of Goiás, under authorization of SISBIO n° 37072-2. Considering the descriptive approach of this work, statistical analysis is not necessary. All procedures were conducted in accordance with ethical principles and were approved by the Institutional Ethics in Research Committee

at the Federal University of Uberlândia (CEUA/UFU n° 067/12).

The study was made in the research laboratory of human and comparative anatomy from the Federal University of Goiás – RC, where the skin head and neck was removed with scissors, scalpel and anatomical tweezers. The adipose tissue of face and epicranium were removed using tweezers and scalpel and muscles of the face and neck were dissected using tweezers, scalpel and scissors and each part of muscle is carefully removed and measured using a precision caliper and weighed. Subsequently, was made a fixation with aqueous 10 % formaldehyde solution to conservation and performed under consecrated techniques in Macroscopic Anatomy.

A Sony Cyber® digital camera was used to the photographical documentation and the description nomenclature adopted is the standard of *Nomina Anatomica Veterinaria* (2017) [13], elaborated by the International Committee on Veterinary Gross Anatomical Nomenclature.

III. RESULTS

Masseter muscle of Maned Wolf is approximately rectangular in shape and obliquely disposed, dorsal to ventral and rostral to caudal, on lateral face of the head, ventrally to ear and extends from ventral border of zygomatic arch to mandible. Seen from lateral face, said muscle is totally covered by an aponeurosis, thicker near the angle of mouth (Fig 1, d).

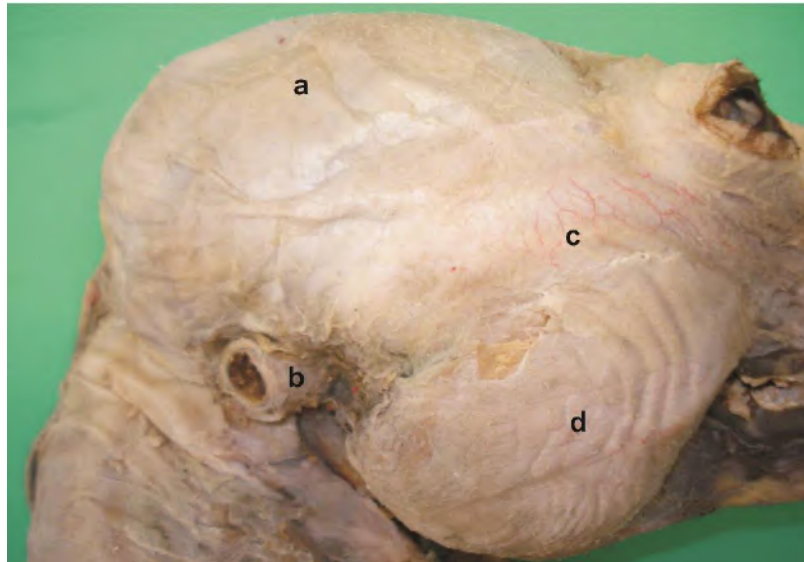


Fig.1: Side view demonstrating aponeurosis of coating on chewing muscles. a- M. Temporal; b- Auditory pavilion; c- Zygomatic arch; d- M. Masseter with aponeurosis.

Once aponeurosis removed, is observed that muscle fascicles are not clearly visible, although small facial septa can be seen, in order to identify the direction of fibers. Even under rough observation, it is observed that its masseter is composed of several parts, which are identified by variable direction of their fibers (Fig 2, c, f).

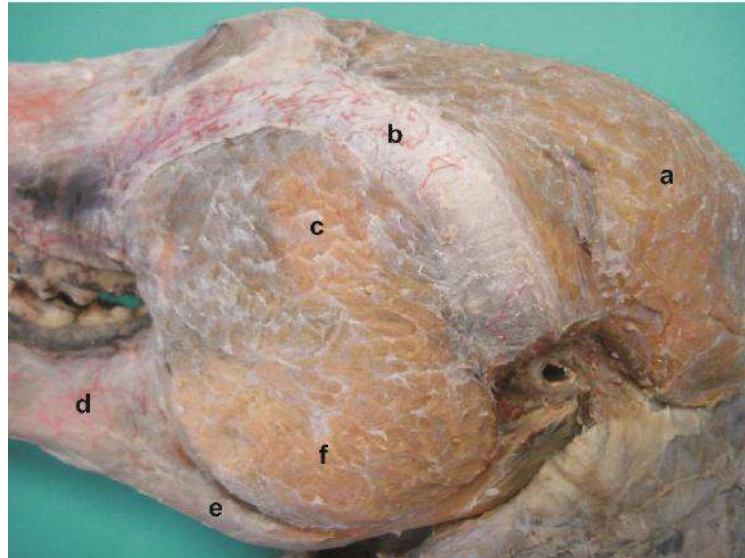


Fig.2: Side view demonstrating mastication muscles after removal of aponeurosis coating. a - M. temporalis; b- Zygomatic arch; c- Zygomatic part of Masseter; d- Jaw; e- Digastric; f- Mandibular part of Masseter.

Initially, four constituent parts of Masseter muscle are identified: Superficial, Rostral, Middle, and Deep. The superficial part is larger, and extends throughout the muscle surface, its fibers can be grouped in a dorsorostral or zygomatic and another ventrocaudal or mandibular, separated by a relatively thick fascia (Fig 3- c, d). The zygomatic belly is thin, laminar in appearance and its fibers are approximately vertical in direction, while mandibular ventricle is very thick, bulky, whose fibers are oblique from rostral to caudal and ventrally.



Fig.3: Side view showing wombs of Masseter. a- Zygomatic arch; b- Auditory pavilion; c- Zygomatic womb of Masseter; d- Mandibular womb of Masseter.

The fibers of zygomatic belly originate along ventral border of zygomatic arch, deepening as they distant from origin, penetrating under mandibular womb, and inserting, through a long aponeurosis, into lateral surface of the angle of mandible, deeply to mandibular ventricle. The fibers of mandibular womb originate from superficial aponeurosis and fascia that separate it from zygomatic womb. As it approaches mandible, the mandibular ventricle

becomes thicker and thicker until its apparently fleshy insertion into lateral surface of branch, the angle, caudal part of mandibular body, as well as angular process of mandible. In view of its great volume, ventral border of mandibular ventricle of Masseter muscle protrudes beyond mandibular border, producing a deep mark in the ventricle of Digastric muscle (Fig. 4).



Fig.4: Side view demonstrating the relationship between mandibular ventricle of Masseter muscle with Digastric muscle. a- Zygomatic arch; b- Auditory pavilion; c- Zygomatic womb of Masseter; d- Mandibular womb of Masseter; e. Digastric.

Deeply, the mandibular womb is separated from zygomatic womb by a relatively thick fascia, mainly in its caudoventral part.

Once superficial part is removed, the Mean and Rostral parts of Masseter muscle are exposed (Fig. 5 - c, d). The Rostral part of Masseter muscle is the smallest of them. It is narrow and long, displaying approximately rectangular shape, arranged almost vertically, behind angle of mouth. Its origin occurs on the lateral side of maxillary process of the zygomatic bone as well as zygomatic process of

maxillary bone. The fibers follow in ventral direction, slightly inclined from rostral to caudal, and are inserted in the side face of caudal part of mandible body. Its surface face is covered up by the Masseter muscle, except at its rostral border which is covered by the same aponeurosis that covers surface. The deep fibers of Rostral part mix with the middle part's rostral fibers almost everywhere, except close to mandibular insert when they are clearly separated by a relatively thick fascia (Fig. 5-d).

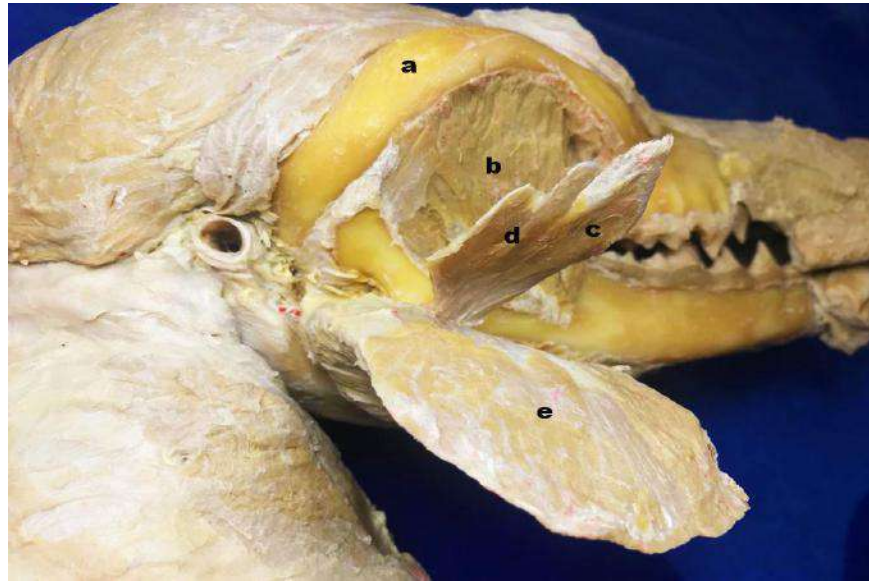


Fig.5: Side view demonstrating portions of Middle Part of Masseter and its caudal and rostral fascicles. a - Zygomatic arch; b- Deep part of Masseter; c- Rostral Fascicle of Middle Part of Masseter; d- Caudal fascia of middle part of Masseter; e - Top part folded from Masseter.

The middle part of Masseter muscle is smaller than superficial part, it exhibits fan form. Its origin occurs at ventral border of zygomatic bone, but soon divides into two fascicles, a more superficially localized caudal fascicle, which is inserted in the middle part of ventral border of masseterine fossa, and a deeper one, the rostral fasciculus, which inserts on the same edge, rostrally to superficial part (Fig. 5 - d, c). Next to origin the fibers of two fascicles are mixed and confused, as well the fibers of Deep Part.

The insertion of superficial, middle and rostral parts of masseter muscle occurs on lateral surface of mandible, rostrally at the angle and angular process of mandible. Once the Middle Part of Masseter muscle is removed, the Deep Part of Masseter muscle is exposed, which is relatively narrow but thick. It is the most caudal of parts, presenting origin along ventral border of caudal half

of zygomatic arch, from where it follows slightly inclined ventrorostrally, towards ventral edge of masseterine fossa.

Its superficial fascicles are inserted through a thick aponeurosis, but most of its fibers have fleshy insertion on the floor of masseterine fossa. Along entire length of the muscle, superficial fascicles are separated from deep ones by a thick aponeurosis, which extends from zygomatic arch to ventral border of masseterine fossa (Figs 7 and 8-b, d).

Although the direction of fascicles that make up Masseter muscle of Maned Wolf allows identification of four or more parts, none of them can be clearly visualized, in all its extension, since fascicles are only separated by thin and irregular ones connective septa. Thus, observing muscle as a whole one perceives that its parts are relatively mixed, mainly close to its origin, forming a muscular "syncytium".

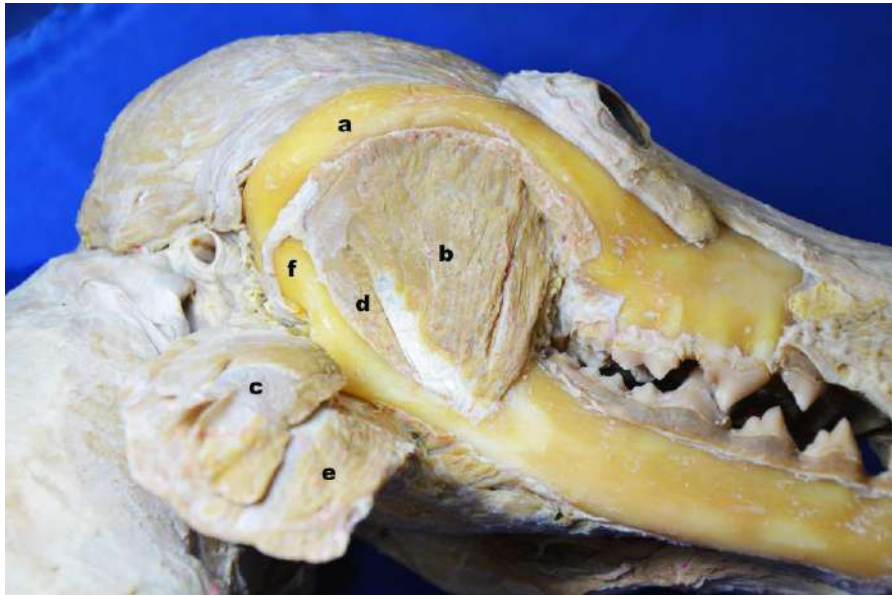


Fig.7: Side view demonstrating muscles of Deep Part of Masseter. a- Zygomatic arch; b- Surface facets of deep part of Masseter; c- Average part of Masseter d- Deep fascias of Masseter; e- Masseter; f- Joint process of mandible.

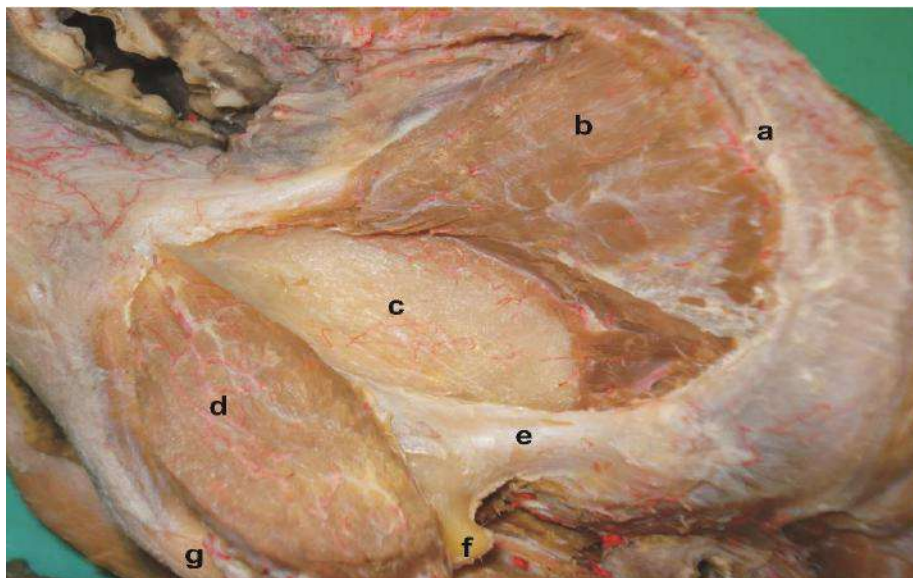


Fig.8: Side view demonstrating muscles of Deep Part of Masseter and fossa masseterina. a- Zygomatic arch; b- Surface facets of deep part of Masseter; c- Masseterine fossa; d- Deep fascicles of Masseter; e- Articular process of mandible; f- Angular process of mandible; g- Digastric muscle.

IV. DISCUSSION

Annotations in Maned Wolf, partially corroborates with descriptions of Turnbull (1970) [14] in wild mammals and Miller et al. (1964) [15], in Dog, regarding the existence of an aponeurosis covering the muscle, its origin in zygomatic arch and its insertion in mandible. Regarding the shape of muscle, a significant difference is observed,

and mammalian muscle presents a relatively triangular shape in the description of Turnbull (1970) [14]; in the Maned Wolf, masseter muscle with a rectangular shape is already present.

Miller et al. (1964) [15] refers to dog masseter muscle presenting three parts, dividing them into Superficial, Middle and Deep. Turnbull (1970) [14]

describes the presence of two parts in mammals, being Superficial and Deep. In Maned Wolf, the presence of four parts is observed: superficial, middle, deep and one that is distinguished from the others, the rostral part. In Maned Wolf a similarity is observed, as to the size of superficial part, in relation to Miller et al. (1964) [15], in dogs when classified this, as the largest of parts of the muscle, having its origin in rostral half of zygomatic arch and being inserted mostly in mandible, in its ventrolateral face and a smaller one below the tympanic bulla.

In spite of this similarity, Maned Wolf there is a division of this part where we can observe fibers arranged in different directions and the existence of a thick fascia that separate them in the caudoventral part. Therefore, they were classified as, zygomatic belly having approximately vertical fibers and mandibular ventricle with oblique fibers in direction of the face. When these two parts meet rostrally there is a mixture between the fibers.

The second part found in Maned Wolf masseter muscle, called Rostral, which was not found in descriptions of dog Masseter muscle, so little of other mammals, is the smallest in relation to other three parts. It originates in maxillary process of zygomatic bone, is disposed vertically posterior to the angle of mouth and inserts in lateral face of caudal part of mandible body. Their deepest fibers are mixed with middle-layered fibers of middle layer, and there is no distinction between them, even close to mandible where they are separated by a thick fascia.

Middle part of Maned Wolf Masseter resembles middle layer described by Miller et al. (1964) [15], in dog, originating from zygomatic arch and its fibers following in ventral direction inserting in masseterina fossa, observing variations in some species which have insertion in anteroventral margin of masseterina fossa. In Maned Wolf the Middle Part is fan-shaped and also presents origin in zygomatic arch, but it is divided into two fascicles, the first being more superficial, caudal fascicle and the second, deepest and rostral fasciculus.

The observations on caudal fascicle agree better with description in dog made by Miller et al. (1964) [15], since it inserts in middle part of ventral margin in masseterina fossa, rostrally inserting rostral fasciculus in the same margin.

Miller et al. (1964) [15] describe little about last layer in deep part, because the impossibility of visualizing its origin motivated by mixing of fibers with those of Temporal muscle. In Maned Wolf was not possible identify it clearly, originating in caudal half of zygomatic arch and

its fibers follow ventro-rostrally inclined, until insertion in masseterina fossa. Miller et al. (1964) [15] describe their insertion with most of fibers at the back of masseterina fossa, while a smaller group is inserted into anterior end of the fossa. In Maned Wolf it was possible to observe the existence of superficial fascicles that are inserted through aponeurosis, and deeper fascicles with fleshy insertion.

V. CONCLUSION

The basic anatomical pattern of Masseter muscle in Maned Wolf is similar to other mammals of similar habit, however, this study possibility observe differences inherent to species, such the arrangement of Masseter muscle with rectangular shape, the presence of four parts, and existence of superficial fascicles that insert through aponeurosis and deeper fascicles with fleshy insertion. Thus, with this descriptive anatomical study, the knowledge of Masseter muscle in Maned Wolf is unprecedented, contributing to the understanding of this group of muscles that is essential for survival, and showed particularities that influence in its biological system, behavior and importance in ecosystem.

REFERENCES

- [1] Fonseca G. A. B.; Rylands A. B.; Costa C. M. R.; Machado R. B.; Leite Y. R (1994). Mamíferos Brasileiros sob Ameaça. In: G. A. B. Fonseca, A. B. Rylands, C. M. R. Costa, R. B. Machado and Y. R. Leite (eds), Livro vermelho dos mamíferos ameaçados de extinção, pp. 1-10. Fundação Biodiversitas, Belo Horizonte, Brasil.
- [2] Michalski J. L.; Barbola I. F.; Luz P.M (2013). Ecologia trófica do lobo-guará, *Chrysocyon Brachyurus* (Illiger, 1811), no Parque Estadual do Guartelá, Tibagi, PR, Brasil. **R. bras. Zool.** Paraná, v. 15.
- [3] Marques R. V.; Fabián M. E (2018). Diversity of medium and large neotropical mammals in an area of mixed rain forest. **Acta Sci. Biol. Sci.**; v. 40.
- [4] Oliveira P. S.; Marquis R. J (2002). The cerrados of Brazil: ecology and natural history of a neotropical savanna. New York: Colombia University Press.
- [5] Faleiro F. G.; Farias A. L. N (2008). Savanas: desafios e estratégias para o equilíbrio entre sociedade, agronegócio e recursos naturais. Embrapa Cerrados. Planaltina.
- [6] Marques R.V.; Fabián M. E (2013). The maned wolf in the ecotone between forest and grasslands at the limits of its distribution in a subtropical environment. **Biosci. J.**, Uberlândia, v. 29, n. 3, p. 751-759.
- [7] Oliveira C.; Teixeira R. A. P.; Conchalo W. L (2004). Uma abordagem contextualizada da anatomia humana e comparada. Projeto desenvolvido junto ao Núcleo de Ensino. Título original: Corpo humano: uma abordagem

interdisciplinar na sala de aula do ensino básico. Instituto de Biociências, Letras e Ciências Exatas, UNESP, Laboratório de Anatomia Comparativa. São José do Rio Preto, p. 291–310.

- [8] Nagahama M. M; Souza C. B. A (2013). Escola experimental de primatas: análise da coerência entre pressupostos e práticas empíricas. **Rev. bras. ter. comport. cogn.**, São Paulo, v.15, n.3, p. 72-87,.
- [9] Lopes I. S. L (2017). Use of human cadavers in teaching of human anatomy in brazilian medical faculties. **Acta Scientiarum**, Maringá, v. 39, n. 1, p. 1-6.
- [10] Herring S. W. M (2007). Masticatory muscles and the skull: a comparative perspective. *Arch. Oral. Biol.* 52(4): 296-299.
- [11] Santos A. L. Q.; Paz B. F.; Barros R. F.; Nalla S. F.; Pereira T. S. (2016). Craniometric Measurements In Maned Wolves *Chrysocyon Brachyurus Illiger, 1815* (Carnivora, Canidae). **Cienc. anim. bras.** Goiânia, v.18, p. 1-9.
- [12] Oliveira T. A. D.; Santee K. M.; Oliveira T. S.; Lopes, B. S.; Fontoura V. G.; Oliveira S. D. T.; Barros R. A. D. C.; Silva Z (2019). Anatomy of Abdominal Aorta in Tatu Peba (*Euphractus sexcinctus* - Linnaeus, 1758): A Descriptive and Comparative Study. **International Journal of Advanced Engineering Research and Science.**
- [13] International Committee on Veterinary Gross Anatomical Nomenclature. *Nomina anatomica veterinaria*. 6. ed. Rio de Janeiro: World Association on Veterinary Anatomist, 2017.
- [14] Miller M. E.; Christensen G. C.; Evans H. E (1964). *Anatomy of the dog*. W. B. Saunders Company, United States of America, Philadelphia.
- [15] Turnbull W. D (1970). *Mammalian Masticatory Apparatus*. Field Museum of Natural History. V.18, N. 2.

Mastication Muscles in Hoary Fox (*Lycalopex vetulus* - LUND, 1842): Descriptive and Comparative Study

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Abstract— Mastication muscles are responsible for lowering and elevation of mandible, which four of them are responsible for mandible elevation in Hoary Fox: Masseter, Temporal, Medial Pterygoid and Lateral Pterygoid; and one for lowering: Digastric. Considering anatomical study of these muscles, the present work aimed to describe, analyze and compare the anatomy of Hoary Fox mastication muscles with data described in literature. In this sense, for this work development, two specimens of Hoary fox (*Lycalopex vetulus*) were used, being fixed in aqueous solution of 10% formaldehyde for conservation, with later description of characteristics, location, size, origin and insertion of muscles. Thus, was observed that Masseter muscle of Hoary Fox is relatively smaller than other species, such as Capuchin Monkey. A slight protuberance was also observed on lateral surface of the face, covering Ramus and Angle of mandible. When analyzed, Medial Pterygoid Muscle is a robust muscle and originates from Palatine and Pterygoid bones, directing dorsocaudally for insertion into medial face of the angle of mandible and adjacent areas, a location that is confused with Masseter (superficial part) insertion. Lateral pterygoid muscle is considerably smaller than medial and extends from sphenoid bone to mandible branch. Temporal muscle is the largest muscle of Hoary Fox head, composed of four parts: Dorsal, Medial, Ventral and Rostral; this muscle has its surface face covered by a thick fascia, the Temporal Aponeurosis.

Keywords— Wild animals, Cerrado Biome, Dissection and Anatomic Study.

I. INTRODUCTION

Hoary Fox is a wild animal of Carnivorous order and Canidae family, classified as the smallest Brazilian canid, not observed in other soils besides Brazilian, it is omnivorous with a food habit comprising mainly fruits, insects and small vertebrates [1]. In Cerrado biome, its habitat is threatened, with an estimated reduction of 10% in the next fifteen years, affecting strongly the population of this specie, being relevant the fact that 30% of specimens are killed by accidental death in roadsides, confrontation with domestic dogs, natural mortality of pups/juveniles, although it is not characterized in extinction, yet vulnerable. In this context, understand its

biological system and components this animal habitat, is essential for its conservation [2-4].

The knowledge of biological system can be evidenced based on animal anatomic study and is relevant consider comparative anatomy, a relatively young science whose objective identify and describe differences and similarities of forms and functions in anatomical structures of different taxonomic groups and is essential for knowledge of species, making possible infer about the importance of animal in environment that is inserted and its evolution [5,6]. Thus, it is worth mentioning the locomotive apparatus of Hoary Fox, which confers support and allows its movement, determining functions for survival and this animal reproduction [1,3,5].

Anatomical study demonstrates that muscles are developed and defined from morphology and habits of each species [7], showing difficulties in describing muscular system of mammals, given wide variability found among species [8], and macroscopic and comparative analysis is required to obtain classification of taxonomic groups [9-11]. In this context, Hoary Fox skeletal striated muscle system contributes to formation of masticatory apparatus [12].

Mastication muscles of vertebrates are initially a single unmaturing muscle mass extending from ventral edge of mandible to the base of skull, divided into two parts, the *Superficial Part* located laterally to mandible and the *Deep Part* medially in the same bone. The identification of this part specializes in mammals from the development of mastication by performing more complex movement of mandible. The *Superficial Parts* evolves to *M. Temporal* and *M. Masseter* and *Deep Part* to *Medial Pterygoid* and *Lateral Pterygoid* [13].

Miller *et al.* (1964) describes that Masseter muscle of Dog is arranged over mandible from ventrocaudal border to zygomatic arch, with surface covered by a thick aponeurosis that emits intermuscular septa. This muscle exhibits differently directed fibers evidencing three layers parts: *Superficial*, *Medial* and *Deep*. The major part is the superficial that presents origin in ventral border of rostral half of zygomatic arch going caudal and ventrally to insert in ventrolateral face of mandible. Some fibers circumvent ventrocaudal border of mandible, are inserted in ventromedial surface and tendinous raphe, between Masseter muscle and Medial Pterygoid muscle.

Temporal muscle is classified as the largest muscle of head and is situated in Temporal Fossa, its origin occurs in greater proportion in parietal bone and lesser extent in temporal, frontal and occipital bones. Its fibers extend face ventrally until insertion into coronoid process of mandible and ventral margin of masseterine fossa. In the lateral part of coronoid process, temporal fibers mix with Masseter, while in medial side, their fibers contact with Pterygoid muscles. A small portion of Temporal muscle fibers originate in dorsal line of nape near the base of zygomatic process and extend parallel to zygomatic arch, gradually mixing with principal mass [12,14].

The Medial Pterygoid muscle originates on lateral surface of pterygoid, palatine and sphenoid bones, extends posteriorly-laterally inserting below the angle of mandible, in posterior margin and posteromedial surface of mandible, ventrally to Temporal and Lateral Pterygoid muscle insertion. The smallest muscle involved in

mastication is Lateral Pterygoid muscle, being short in relation to medial Pterygoid, with origin occurring in sphenoid bone and extending ventrally through fossa alar, orbital fissure and round foramen, inserting in medial surface at mandible condyle, ventrally its articulate face. Digastric muscle originates in jugular process of occipital bone, proceeding to ventral border of mandible, is disposed medially to parotid gland. It has a fleshy insertion in ventromedial border of mandible, approximately 2.5 cm at the level of dorsal canine tooth. A small group of fibers extend forward the mento [12,14,15].

In face of the presented evidence, Hoary Fox dissection is necessary for descriptive and comparative anatomic study, contributing for better understanding of this animal mastication muscles, essential pattern for knowledge of particularities inherent it species, that influence in biological system and consequently in behavior importance of Hoary Fox in ecosystem.

II. MATERIAL AND METHODS

The present paper is a descriptive and comparative anatomical study with one male and one female specimen of Hoary Fox, obtained from accidental death on the roadsides of Brazilian Southeast of Goiás, under authorization of SISBIO n° 37072-2. All procedures were conducted in accordance with ethical principles and approved by the Institutional Ethics in Research Committee at the Federal University of Uberlândia (CEUA/UFU n° 067/12).

The study was made in the research laboratory of human and comparative anatomy from the Federal University of Goiás – RC, where the skin head and neck was removed with scissors, scalpel and anatomical tweezers. The adipose tissue of face and epicranium were removed using tweezers and scalpel and muscles of the face and neck were dissected using tweezers, scalpel and scissors subsequently was made a fixation with aqueous 10 % formaldehyde solution to conservation. The preparation of anatomical pieces was performed under consecrated techniques in Macroscopic Anatomy.

The Sony Cyber® digital camera was used to the photographic documentation and the description nomenclature adopted is the standard of *Nomina Anatomica Veterinaria* (2017) [16], elaborated by the International Committee on Veterinary Gross Anatomical Nomenclature. Considering the descriptive approach of this work, statistical analysis is not necessary.

III. RESULTS

Mastication muscles are meant as a group of muscles responsible for lowering and elevation of mandible. Four muscles are responsible for elevation of mandible in Hoary Fox: *Masseter*, *Temporal*, *Medial Pterygoid*, *Lateral Pterygoid*; and one to lowering: *Digastric*.

Masseter muscle: Small when compared to other species, e.g. Capuchin Monkey. Nevertheless, forms slight protuberance on lateral surface of face, covering branch and angle of mandible. It is covered, on outer surface, by a thick aponeurosis, the *masseterine aponeurosis*. A second aponeurosis is present inside the muscle, giving it appearance in layers or parts. The

separation between parties is obscure, with no clear separation between them. Thus, four parts are described: *Surface*, *Medial*, *Deep* and *Rostral*.

Superficial part is the most voluminous, originating from ventral border of zygomatic arch. Fascicles muscle are small and involved by thin perimysium, not easily identified with naked eye. The fibers orientate in palmar direction, in direction of branch and angle of mandible, where they are inserted. A group of fibers inserts at caudal border of mandibular branch and the edge of angle of mandible and remainder at ventral border of mandibular body. Any case of fibers extends beyond the edge of bone, becoming protrusions beyond it.

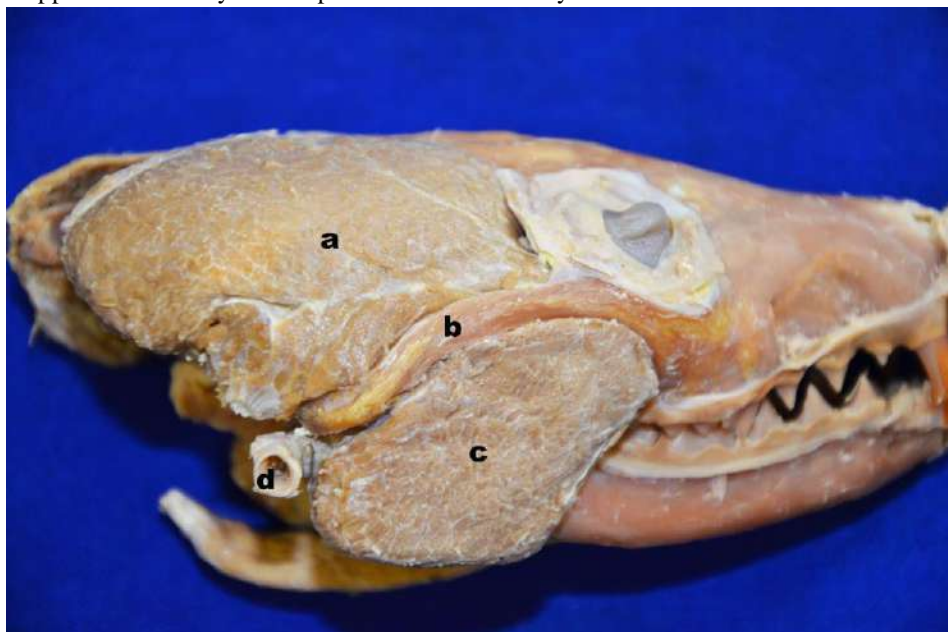


Fig.1: a- Temporal Muscle; b- Zygomatic Arc; c- Superficial part of the Masseter Muscle; d – Auditive Pavilion

Middle Part Masseter muscle is smaller than superficial, is located medially and incompletely separated from this, through an aponeurotic lamina. It presents a quadrilateral form, whose origin occurs in ventral border of rostral half in zygomatic arch. Its fibers are ventrocaudally inserted in ventral edge of masseterina fossa, ventrally to coronoid process of mandible. It covers Deep Part of Masseter muscle and Vertical Part of Temporal Muscle, near its insertion in coronoid process of mandible. Its rostral part is approximately cylindrical, while remainder laminar. Much of its extension is separated from the Deep by an aponeurosis.

Deep Part of Masseter muscle is smaller than superficial part, but larger than Middle Part. Originates from the deep face of caudal half of zygomatic arch, where entirely merged with ventral part of temporal muscle. Its fibers ventrally intrude into the floor of the fossa masseterina, along with the Ventral part of Temporal muscle.

Rostral Part of Masseter muscle is the smallest segment of superficial part, whose origin occurs at rostral base of zygomatic arch and close to mandibular insert, mixed with superficial part of Masseter muscle.

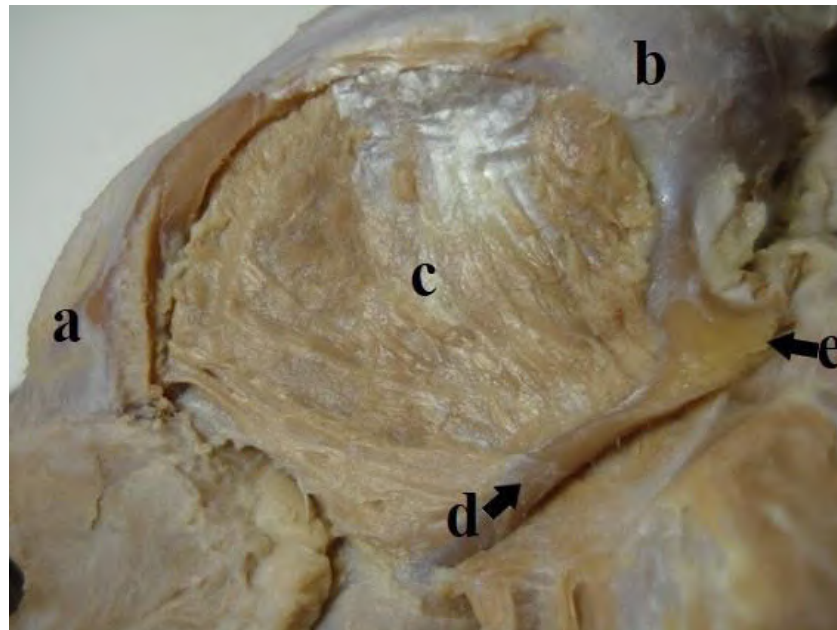


Fig.2: a- Frontal Bone; b- Zygomatic Arc; c- Average Part of Masseter Muscle; d- Mandibular Body; e- Angular Process of Mandible.

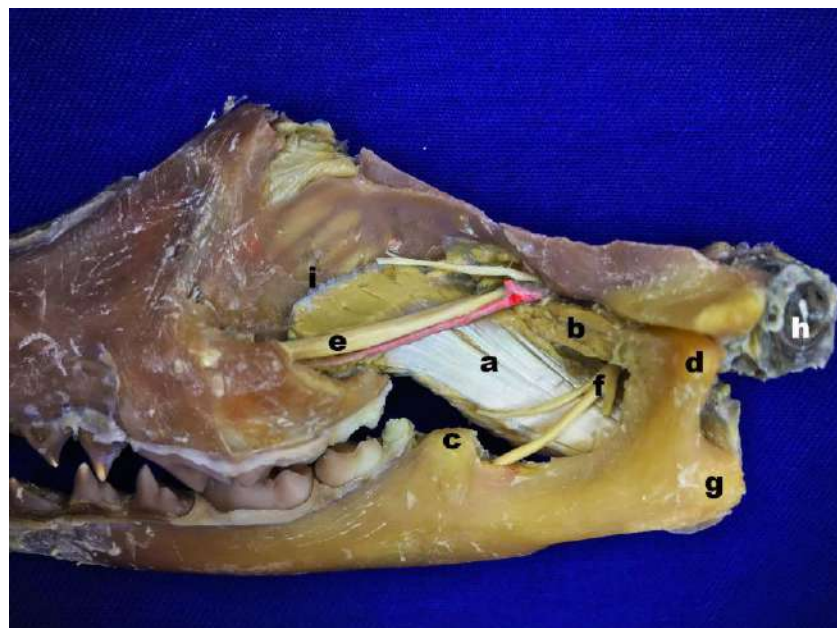


Fig.3: a- Medial Pterygoid; b- Lateral Pterygoid; c- Coronoid process; d - Condylar process of mandible; e- Maxillary Nerve; f- Mandibular Nerve; g- Angular Process of Mandible; h- Hearing Pavilion; i- Pterygoid process.

Medial Pterygoid Muscle: Robust muscle that originates from palatine and pterygoid bone, directed dorsi-caudally to insert into medial aspect of mandible and adjacent areas, where is confused with insertion of Masseter muscle (superficial part).

Lateral Pterygoid Muscle: Smaller than medial and extends from sphenoid bone to mandible branch. Its

origin occurs in caudal aspect of sphenoid bone and its fibers are directed rostrocaudally to insert in medial aspect of branch until cranial border of mandible branch, until its condyle.

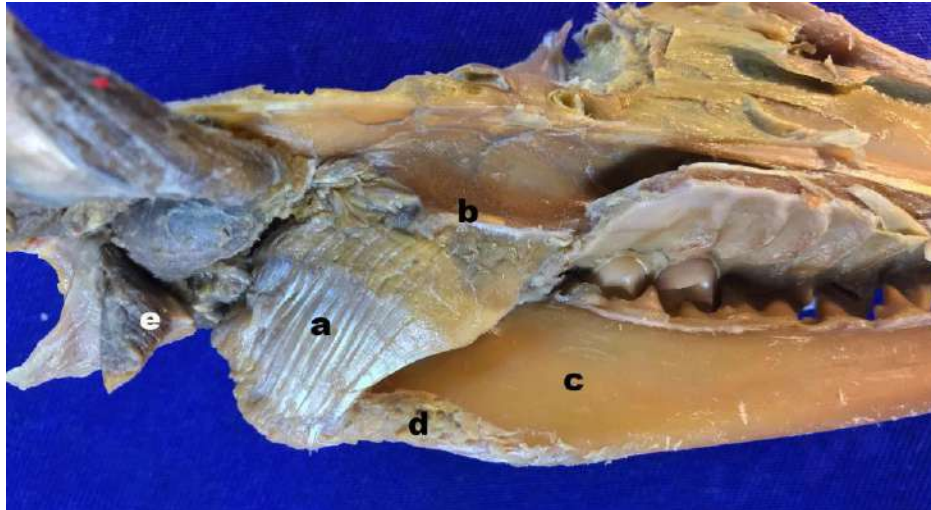


Fig.4: a- Medial Pterygoid; b- Pterygoid process; c- Jaw Body; d- Insertion of Digastric Muscle; e- Origin of Digastric Muscle.

Temporal Muscle: The largest muscle in this animal head. Consists four parts: *Dorsal, Middle, Ventral* and *Rostral*. The superficial face of Temporal Muscle is masked by a thick fascia, the *temporal aponeurosis*, while a thick deep aponeurosis separates Dorsal Part of muscle in *Superficial* and *Deep fibers*.

Superficial fibers of dorsal part have a broad origin along interparietal crest and deep face of temporal fascia, from frontal bone to occipital, while deep fibers are fixed to surface of parietal bone. Much of superficial and deep fibers, inserts in aponeurosis that separates the two parts. The other fibers, together with referred aponeurosis and curves, rostroventrally, converging under zygomatic arch and insert into coronoid process of mandible.

Ventral fibers constitute a large muscular fascicle that originates in deep face of zygomatic arch, together with fibers of Deep Part of Masseter muscle. Both muscles are fused, constituting a single muscular mass, whose fibers assume ventrostrally direction by inserting in floor and edges of masseterina fossa of mandible.

Fibers of Rostral Part is smaller than the other four, located medial to temporal process of zygomatic bone and maxillary bone, originate at rostral base of zygomatic arch and adjacent areas of maxillary and frontal bone, ventrally to insert into medial face of mandible coronoid process.

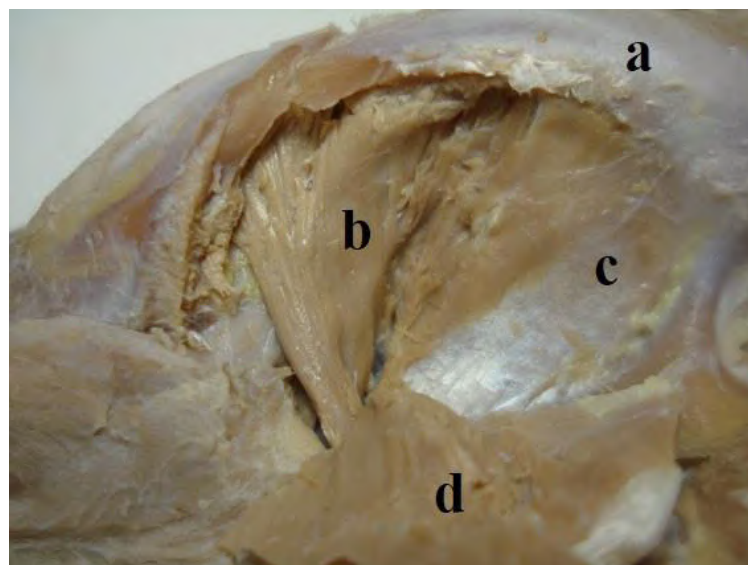


Fig.5: a- Zygomatic Arch; b- Rostral Part of Temporal Muscle; c- Deep Part of Masseter Muscle; d - Temporal Medial Muscle, rebounded.

Thus, the four parts of temporal muscle forms a large muscle mass orientated from flow to rostral and ventrolaterally, converging beneath rostral part of zygomatic arch, going into coronoid process of mandible and adjacent areas. The fibers of Dorsal Part are, in caudal half, sharply separated from Middle Part, but rostrally they merges.

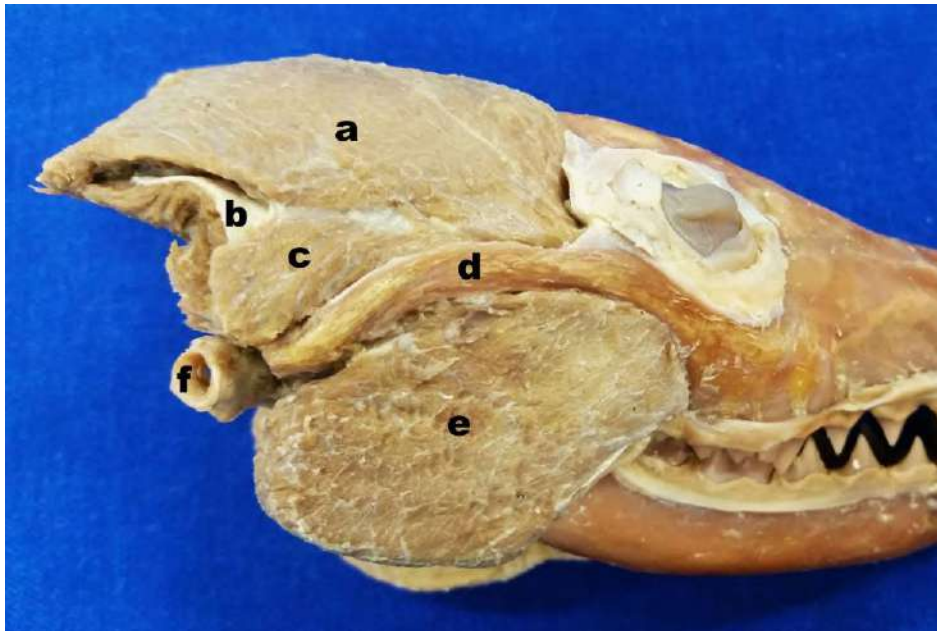


Fig.6: a- Superficial Part of Temporal muscle; b- Deep Part of Temporal Muscle; c- Media Part of Temporal muscle; d- Zygomatic arch; e- Muscle Masseter; f- Auditory Pavilion.



Fig.7: a- Temporal Muscle; b- Insertion of Temporal Muscle; c- Mandible Masseterine Fossa; d- Angular process of mandible; e- Temporomandibular Joint; f- Auditory Pavilion; g - Muscle Masseter rebated.

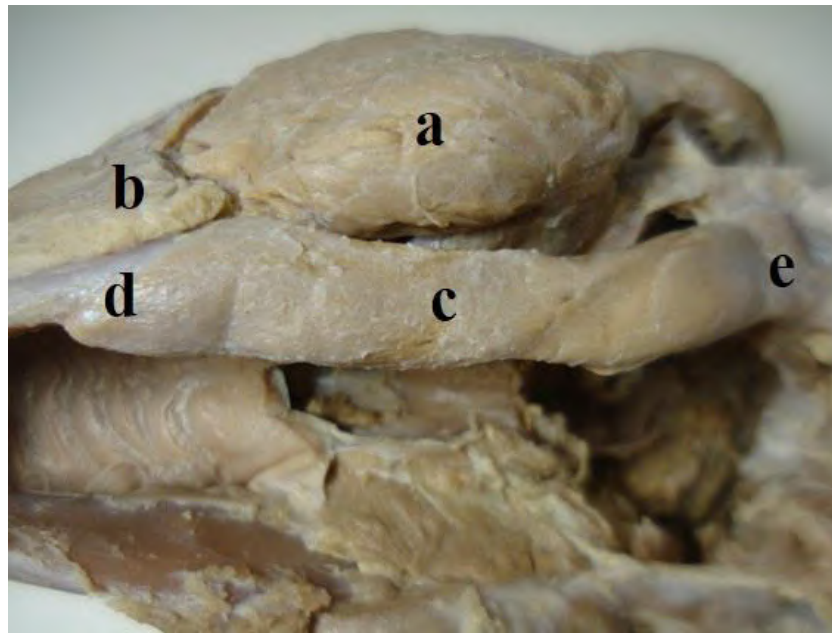


Fig.8: a- Masseter muscle; b- Mandible; c- Digastric Muscle; d- Mandibular insertion of Digastric Muscle; e- Occipital insertion of Digastric Muscle.

Digastric Muscle: This muscle, beside the name, is monogastric, since there is no intermediate tendon. The muscle extends from occipital bone (origin) to the angle and ventral edge of mandible. Both origin and insertion are apparently meaty, since the fixation tendons cannot be identified. Its shape is approximately cylindrical exhibiting the same dimensions throughout its length

IV. DISCUSSION

Hoary Fox Masseter muscle produces a slight protuberance on lateral face, disposed on branch of mandible, covered by a thick aponeurosis called *Masseterina Aponeurosis*. Inside the muscle there is a second aponeurosis that contributes to partially separate muscle mass into layers.

Miller *et al.* (1964) [12] described in dogs Masseter muscle, the presence of a superficial aponeurosis covering the muscle and its division into three layers: *Superficial*, *Medial* and *Deep*, with fibers directed in different directions. Turnbull (1970) also identifies, in mammals, a division of masseter, but describes only two layers: *Superficial* and *Deep*. In Hoary Fox, there is a division into four parts: *Superficial*, *Meadiial*, *Deep* and *Rostral*, where *Superficial Part* being the largest. Its fascicles are small with a thin perimissio making visualization difficult to naked eye. Here, superficial part presents an origin in ventral border of zygomatic arch, its fibers follow palmar palate until insertion in the angle of mandible, in caudal border of mandibular branch, in the border of the mandible angle

and ventral border of mandibular body. The fibers projection beyond the insertion edge, produces a protrusion beyond the edge of the bone.

Miller *et al.* (1964) [12] describes the origin of dog Masseter muscle with the origin at ventral border of zygomatic arch, from rostral half. When its fibers follow caudal and ventrally, inserting in ventrolateral face of mandible body and ventromedial surface to tendinous raphe, between Masseter and Medial Pterygoid. Turnbull (1970) [17] identifies the origin of Masseter in zygomatic arch, in its lateral bony border, where the fibers follow ventrocaudally, until its insertion in ventrolateral border of mandible body, angle and angular process of mandible.

On the other hand, the *Middle Part*, which is smaller than superficial part, is identified together with rostral part, the latter having a cylindrical shape rostral and laminar caudally. The *Middle Part* is located medial to *Surface Part*. Its shape is quadrilateral and its origin occurs on ventral border of rostral half of Zygomatic Arc. Its fibers follow ventrocaudally, inserting in ventral border of masseterina fossa and ventrally to coronoid process of mandible.

As described by Miller *et al.* (1964) [12], the middle part as being the thinnest, originating from Zygomatic Arc and caudally in relation to surface layer. Most of its fibers follow ventrally and insert into ventral margin of Masseterina Fossa of mandible. In Hoary Fox is observed that a group of fibers presents insertion in ventral border of Masseterina Fossa, ventrally to coronoid process of mandible.

The Deep Part of Masseter, is larger than Medial. Its origin occurs in deep face of caudal half on zygomatic arch, merged with Ventral Part of Temporal. Is possible observe that its fibers follow ventrorostrally and inserted in floor of Masseterina Fossa of mandible, together with ventral part of Temporal muscle. These observations are similar to Miller *et al.* [12] descriptions, that state identification of Deep Part is not easy due its mixed fibers with those of Temporal muscle and the Deep Part is inserted in Masseterina Fossa [15]. The Rostral Part of Masseter muscle, seen in Hoary Fox, is not described in other species.

Medial Pterygoid Muscle of Hoary Fox is robust, presenting origin in Palatine and Pterygoid bones, its fibers follow dorsocaudally, inserting itself in medial aspect of angle mandible and in adjacent areas. In this region there is also insertion of superficial part of Masseter muscle, there being a mixture of fibers of both parts. In dog, according to Miller *et al.* (1964) [12], Medial Pterygoid muscle originates from bones: Pterygoid, Palatine and Sphenoid, in line with Hoary Fox observations. The fibers of this muscle extend posteriorly and laterally to insert into the angle, caudal margin and caudally medial aspect of mandible, ventrally to insertion of Temporal and Pterygoid Lateral muscles [12,14,15].

In turn, in Hoary Fox, *Lateral Pterygoid muscle* is smaller than medial, the origin occurs on caudal surface of sphenoid bone and its fibers continue to palpably insert into medial aspect of mandible branch, up to condyle. On the other hand, Digastric Muscle in Hoary Fox is monogastric, since there is no intermediate tendon, although the same authors state that there is independent innervation for each part of muscle. In Hoary Fox its origin, in occipital bone, is fleshy and its fibers insert in angle and ventral border of the mandible body, in agreement with Miller *et al.* (1964) [12] descriptions in dog.

Temporal Muscle of Hoary Fox, as well in dogs [12], is the largest muscle in head. In Hoary Fox there are four parts: *Dorsal*, *Medial*, *Ventral* and *Rostral*. The Dorsal, Middle and Rostral parts converge under rostral part of zygomatic arch to insert into coronoid process of mandible and adjacent regions. In turn, the temporomandibular muscle in dog [12], without divisions, and originated in parietal, temporal, frontal and occipital bone, whose insertion occurs also in Coronoid Process and ventral margin of Masseterina Fossa, sometimes mixed with Masseter fibers. As related by Miller *et al.* (1964) [12], in dog, a small portion of fibers presents origin near zygomatic process of temporal bone, in dorsal line of nape and inserts in zygomatic arch mixing with the

main mass of Temporal muscle. This part of the muscle, in dog, corresponds to average part verified in Hoary Fox.

CONCLUSION

The present work demonstrated that Hoary Fox mastication muscle shows similarities with other canids; however, anatomical pattern demonstrated through dissection that Masseter muscle produces a slight lateral protuberance on face, disposed on the branch of mandible, covered by a thick aponeurosis called Aponeurosis Masseterina and inside the muscle, there is a second aponeurosis contributing in separation of muscle mass in layers. Thus, the present paper presents unpublished data about Hoary Fox anatomy, contributing to the knowledge and understanding of this group of muscles, which some particularities influence in biological system of this species, its behavior and importance in ecosystem.

REFERENCES

- [1] Dalponte J. C.; Lima E. S (1999). Disponibilidade de frutos e a dieta de *Lycalopex vetulus* (Carnivora-canidae) em um cerrado de Mato Grosso, Brasil. **Rev. Bras. Bot.**, São Paulo, v.22(2).
- [2] Bocchiglieri A; Mendonça A. F; Henriques R. P. B (2010). Composition and diversity of medium and large size mammals in the Cerrado of central Brazil. **Biota neotrop.** (Online, Ed. port.); v. 10(3), 169-176.
- [3] Lemos F. G.; Azevedo F. C.; Beisiegel B. M (2013). Avaliação do risco de extinção da Raposa-do-campo. **Biodiversidade Brasileira.** v.3(1), 16-171.
- [4] Mattos S. H. V. L.; Vicente L. E.; Perez Filho A.; Piqueira J. R. C (2016). Contributions of the complexity paradigm to the understanding of Cerrado's organization and dynamics. **An Acad Bras Cienc. Dourados**, v.88(4), 2417-2427.
- [5] Oliveira C.; Teixeira R. A. P.; Conchalo W. L (2004). Uma abordagem contextualizada da anatomia humana e comparada. Projeto desenvolvido junto ao Núcleo de Ensino. Título original: Corpo humano: uma abordagem interdisciplinar na sala de aula do ensino básico. **Instituto de Biociências, Letras e Ciências Exatas, UNESP, Laboratório de Anatomia Comparativa.** São José do Rio Preto, 291-310.
- [6] Hecht L. P; Larrazábal M. A (2018). Uso de nuevos recursos tecnológicos en la docencia de un curso de anatomía con orientación clínica para alumnos de medicina. **Int. J. Morphol.** Arica, v.36(3), 821-828.
- [7] Di Dio L. J. A.; Amatuzzi M. M.; Cricenti S. V (2003). **Sistema muscular.** In: DI DIO, L. J. A.

- (Ed.). Tratado de anatomia sistêmica aplicada. São Paulo: Atheneu, p. 187-287.
- [8] Orr R. T (1986). **Mamíferos**. In: Biologia dos vertebrados. 5.ed. São Paulo: Roca, p.183-246.
- [9] Storer T. I.; Usinger R. L.; Stebbins R. C.; Nybakken J. W (2000). **Zoologia Geral**. 6ªEd. São Paulo: Nacional.
- [10] Ribeiro O. M (2002). **Estrutura e Análise de Balanços**. 6ª Ed., São Paulo: Saraiva.
- [11] Aversi-Ferreira T. A.; Vieira L. G.; Pires R. M.; Silva Z.; Penha-Silva N (2006). Estudo anatômico dos músculos flexores superficiais do antebraço no macaco *Cebus apella*. Biosci. **J. Uberlândia**, v. 22(1), 139-144.
- [12] Miller M. E.; Christensen G. C.; Evans H. E (1964). **Anatomy of the dog**. W. B. Saunders Company, United States of America, Philadelphia.
- [13] Testut L.; Latarjet A (1979). **Tratado de Anatomia Humana**. Salvat Editores. Mallorca, 41-Barcelona, Espanha..
- [14] Getty R (2008). **Sisson e Grossman: anatomia dos animais domésticos**. 5. ed. Rio de Janeiro: Guanabara Koogan.
- [15] Dyce K. M.; Sack W. O.; Wensing C. J. G (2010). **Tratado de anatomia veterinária**. 4. ed. Rio de Janeiro: Elsevier.
- [16] International Committee on Veterinary Gross Anatomical Nomenclature. Nomina anatomica veterinaria. 6. ed. Rio de Janeiro: World Association on Veterinary Anatomist, 2017.
- [17] Turnbull W. D (1970). **Mammalian Masticatory Apparatus**. Hoary Museum of Natural History. v.18(2).

Macroscopic Anatomic Study of Gastrocnemius, Superficial Flexor Digitorum and Soleus Muscles of Coati (*Nasua nasua*)

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Abstract— Coati (*Nasua nasua*) taxon is poorly described, since the contribution to knowledge and development of biological system from this specie, so this paper aimed analyzes and describes the anatomy of the gastrocnemius, superficial flexor digitorum, and soleus muscles in Coati. The present study demonstrate that racoon gastrocnemius of Coati, located within caudal part of leg, is a robust muscle in relation to physical size of the animal. One head of muscle is medial and other relatively larger than medial, medial head originates from the plantar surface of distal end of femur and lateral head epicondyle incorporate by a common tendon with soleus muscle at distal aspect of calcaneus. Superficial flexor digitorum muscle is a long muscle, whose womb is surrounded by heads of gastrocnemius muscle. Its origin is common with lateral head of gastrocnemius muscle and its insertion is in plantar aponeurosis, after it crosses calcaneus distally. Soleus muscle is a long, flat muscle, deep to gastrocnemius and superficial flexor digitorum muscles, whose origin is the head of fibula and surrounding areas. The common insertion of the soleus muscle with the gastrocnemius muscle forms the Achilles tendon.

Keywords— Coati, Raccon, Comparative Anatomy, Descriptive Anatomy and Muscles.

I. INTRODUCTION

Comparative anatomy of wild animals has taken center stage in laboratory studies and research as well as specialized journals, probably due the importance of comparative anatomy in phylogeny understanding and following evolutionary lines of taxonomic groups. Anatomic structure of wild species can be helpful in understanding the biology of these groups and establishing relationships between form and function of similar structures present in different groups [1].

All anatomical systems that make up the body of an animal have importance in integrity and survival; however, the locomotor system is particularly critical because it supports body movement. The muscular system alone can produce movement, a fundamental function in defense, feeding, and reproduction [1]. Providing body contour, muscles undergo adaptation providing information on dietary habits, reproductive behavior, and body posture [2]. In many instances, macroscopic anatomy studies have been displaced by microscopic

studies; however, macroscopic studies are necessary for complete physiological understanding of organisms.

Cerrado biome is highly complex, ranking second in size among Neotropical biomes. Its habitats range from open fields of grasslands to gallery forests, dry forests and semi-deciduous [3]. This great variety supports the development and hosting of a large number of native species [4]. Mammalian fauna of Cerrado biome is comprised of a large number of species, including several large carnivorous from the coati group (*Nasua nasua*), which is the object of investigation in the present research.

The evolutions of species in Neotropics determine the emergence of different phyletic lines occupying different areas. Thus, those occupying open areas have developed different characteristics from those that inhabit dense forests; in addition, anatomical structures have been adapted according to the environment, food and reproduction. Among the mammals of cerrado, there are walkers, runners, jumpers, and those that adopt a combination of these

characteristics, in accordance with the requirement of the moment. The muscles are the main protagonists in this process and are therefore, well adapted to specific motions even though the basic structure is maintained. Raccoon is a Procionídeo that is well adapted to Cerrado biome. The racoon can live and breed in small forests, sometimes in communion with human beings. It is a semi-arboreal animal with plantigrade locomotion habits. The habit of stepping using the entire foot has resulted in consistent muscle adaptations. [5-6].

Based on anatomical comparative observations to the development of anatomic studies and considering that the anatomy of gastrocnemius, superficial flexor digitorum and soleus muscles Coati (*Nasua nasua*), were not until described and will contribute to the knowledge of the biological system and, whenever possible, to infer the necessary adjustments to their “modus vivendis”, the present study was designed to dissect and describe these muscles of this specie distributed almost every South American.

II. MATERIAL AND METHODS

The present work is a descriptive anatomical study with two specimens of Coati (*Nasua nasua*) a male and a female, of unknown age, obtained from accidental death on the roadsides of Brazilian Southeast of Goiás, donated from “Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis - IBAMA”, under authorization of SISBIO n° 37072-2. Considering the descriptive approach of this work, statistical analysis is not necessary. All procedures were conducted in accordance with ethical principles and were approved by the Institutional Ethics in Research Committee at the Federal University of Uberlândia (CEUA/UFU n° 067/12).

The study was made in the research laboratory of human and comparative anatomy from the Federal University of Goiás – RC, where the specimens were submitted to fixation with aqueous 10% formaldehyde solution to conservation. The preparation of anatomical pieces was performed under consecrated techniques in Macroscopic Anatomy.

The Sony Cyber® digital camera was used for the photographic documentation and the description nomenclature adopted is the standard of *Nomina Anatomica Veterinaria* (2017) [7], elaborated by the International Committee on Veterinary Gross Anatomical

Nomenclature. Morphometric measurements were performed as follows with a ZAAS precision 25 cm caliper. 1) The length of the muscle belly was obtained in the long axis of the womb. 2) The width was the average of three values: one proximal a distance of 1 cm from the origin (MP), another at the widest part of the belly (MM) and the third, at a distance of 1 cm from the distal end of the belly (MD). The values corresponding to the thickness of the stomach were obtained using the same protocol used for the width. To obtain the approximate volume of the muscle belly, average values of width and thickness were calculated, then values were multiplied using the following formula: length X width X thickness, with approximate results reported in cm³.

III. RESULTS

Gastrocnemius: The description of Coati (*Nasua nasua*) gastrocnemius muscle was performed in conjunction with superficial flexor digitorum muscle description, due the latter is located between the two heads of the gastrocnemius and partially adhered to the lateral head, forming a mass continues only separable by scalpel. The gastrocnemius muscle, along with the superficial flexor digitorum muscle, is a robust structure of the leg with respect to the physical size of the animal. The average length of the tibiae were left tibia (TE) 8.5 cm and right tibia (TD) 8.6 cm, consistent with a medium-sized animal (2.0 to 3.0 kg). The volume of the right muscle mass, including two heads of the gastrocnemius and the superficial flexor, is approximately 13.42 cm³ and left around 12.84 cm³. The gastrocnemius muscle of coati (*Nasua nasua*) consisted of two parts: the medial head and lateral head, with the lateral head partially adhered to the flexor digitorum superficialis muscle throughout its length and sharing a common origin. Thus, the lateral muscle mass, comprising the sum of the belly side volume with the volume of the flexor digitorum superficialis, was greater than the medial mass. The right side belly of the gastrocnemius (VLDG) = 4.89 cm³; belly superficial flexor of the right fingers (VFSDD) = 3.73 cm³, totaling 8.62 cm³ against a volume of the belly of the right medial head (VCMD) = 4.80 cm³. To the left antimer, there was a left lateral belly volume of the gastrocnemius (VLEG) = 4.80 cm³; belly superficial flexor digitorum (VFSDE) = 3.62 cm³, totaling 8.42 cm³ against the left medial belly of the gastrocnemius volume = 4.42 cm³ (Figure 1 and 2)(table 1-2).

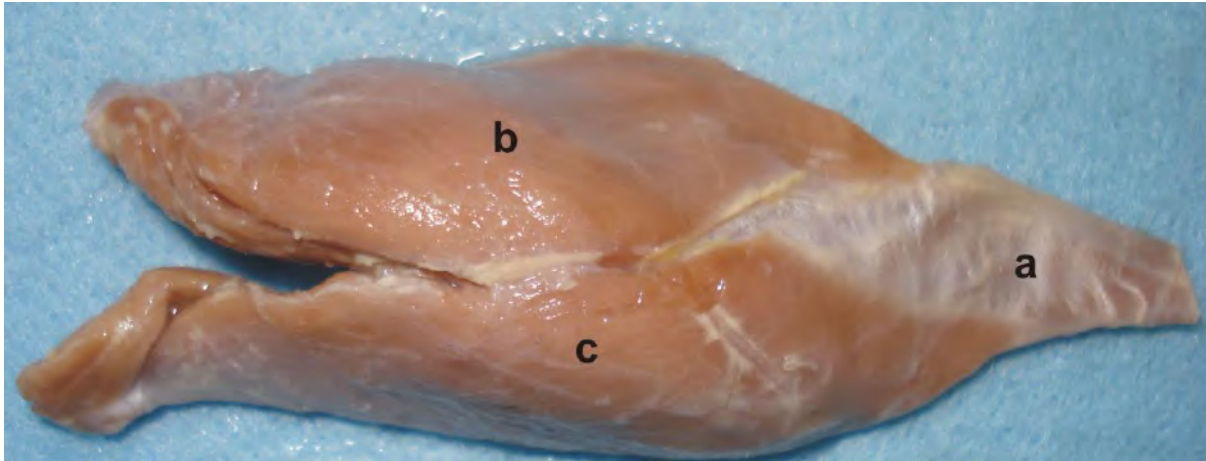


Fig.1: Photomacrograph of the coati leg, view - a- aponeurosis common insertion, b- lateral head of m. gastroclemius, c medial head of m. gastrocnemius.



Fig.2: Photomacrograph of the coati leg: cranial view - a- lateral head of m. gastrocnemius, b- m. superficial flexor digitorum, c medial head of m. gastrocnemius.

Table 1: Morphometric measurements (cm) of medial belly right gastrocnemius muscle of raccoon.

VENTRE	LARGURA				ESPESSURA				VOLUME
	PR	MM	DI	MD	PR	MM	DI	MD	VOL/cm ³
6,4	1,1	2,1	1,2	1,5	0,6	0,5	0,4	0,5	4,80

Table 2: Morphometric measurements (cm) of left belly of the medial gastrocnemius in Coati.

VENTRE	LARGURA				ESPESSURA				VOLUME
	PR	MM	DI	MD	PR	MM	DI	MD	VOL/cm ³
5,9	1,3	2,1	1,1	1,5	0,6	0,6	0,3	0,5	4,42

The medial head was longer: VMD = 6.4 and = 5.9 cm VME; closer: VMD = 1.5 and = 1.5 cm VME, and thinner: VMD = 0.5 and = 0.5 cm VME, than the lateral head, whose length was: VLD = 5.1 and VLE = 5.0 cm; width: VLD = 1.6 and VLE: 1.6 cm and thickness: VLD = 0.6 and = 0.6 cm VLE, making a total gastrocnemius muscle volume of right side

(MGD) = 9.69 cm³ and left side (MGE) = 9.22 cm³. Thus, the right gastrocnemius is relatively larger than the left gastrocnemius. Its origin was small and fleshy, located medial to the medial condyle above-crest and a major origin, tendon, also in the above-medial condylar crest; however, the distal fixation fleshy. The proximal third of medial head was roughly cylindrical and narrow, while the middle third was flat and wide. Within the distal third and continuing to its insertion, the aponeurosis was fused with the aponeurosis of the lateral head. The medial head is completely independent of the lateral head and superficial flexor digitorum muscle (Figures 3)(tables 3-4).

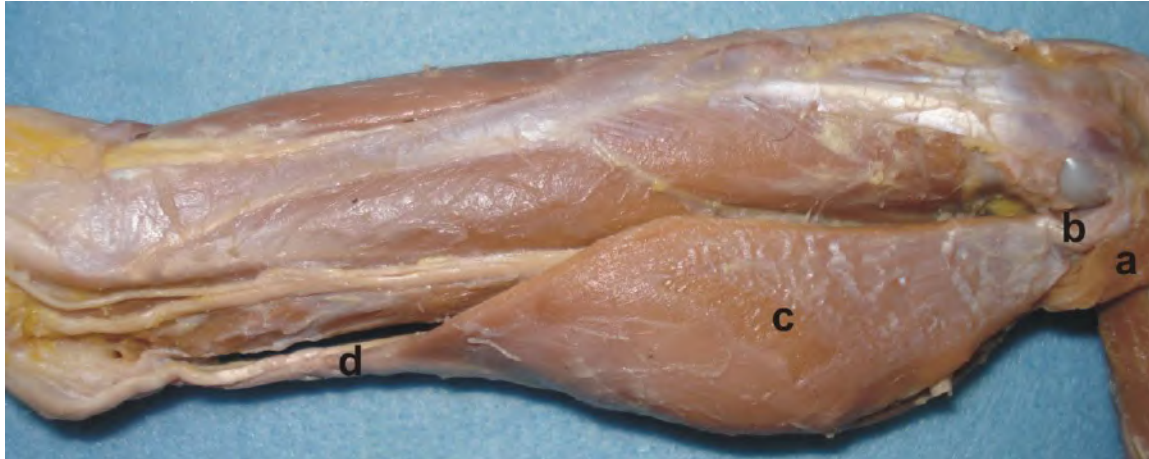


Fig.3: Photomicrograph of the coati leg: medial view - a- fleshy origin of the medial head of m. gastrocnemius; b- tendon origin of the medial head of m. gastrocnemius, c belly of the medial head of m. gastrocnemius, d- Achilles tendon.

Table 3: Morphometric measurements (cm) of right belly of gastrocnemius muscle in raccoon.

VENTRE	LARGURA				ESPESSURA				VOLUME
	PR	MM	DI	MD	PR	MM	DI	MD	VOL/cm ³
5,1	1,2	2,1	1,5	1,6	0,6	0,7	0,5	0,6	4,89

Table 4: Morphometric measurements (cm) of left belly of the gastrocnemius muscle in Coati.

VENTRE	LARGURA				ESPESSURA				VOLUME
	PR	MM	DI	MD	PR	MM	DI	MD	VOL/cm ³
5,0	1,2	2,0	1,6	1,6	0,6	0,7	0,5	0,6	4,80

Lateral head was shorter than medial closer, with a nearly cylindrical shape near its origin, widening in distal direction. Its origin was in supra-condylar side crest and caudolateral capsule of the knee adjacent to superficial flexor digitorum muscle. The belly of lateral head was separated from the belly of superficial flexor digitorum muscle throughout its length by a thin aponeurosis, visible superficially as a small groove (Figure 4).

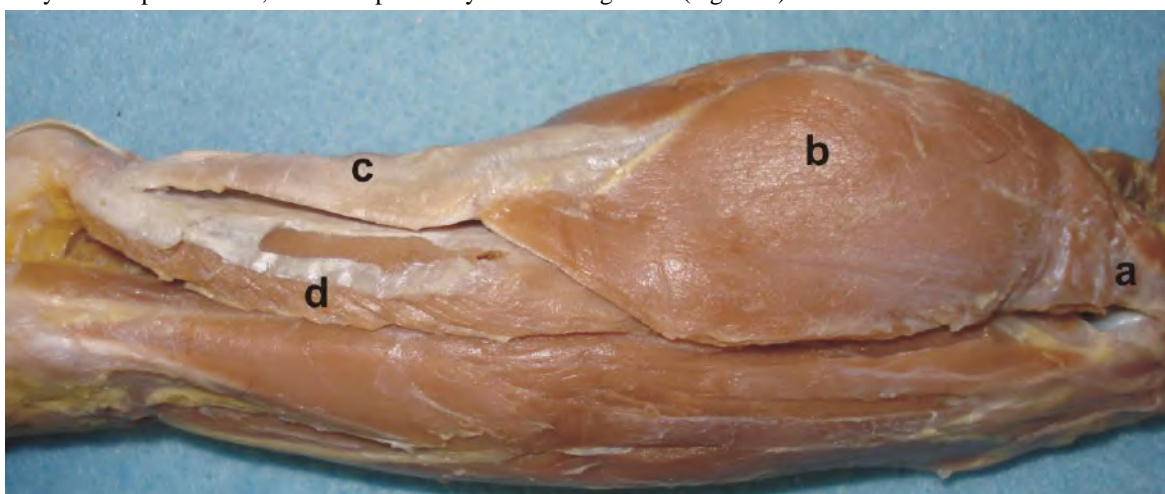


Fig.4: Photomicrograph of the coati leg: Lateral view - a- origin of the lateral head of m. gastrocnemius; b- belly of the lateral head of m. gastrocnemius, c Achilles tendon, d-m. soleus.

In cranial view, the side of head and superficial flexor digitorum muscle was identified by a groove, while in caudal view, two grooves separate the flexor of both heads of the gastrocnemius (Figure 5).

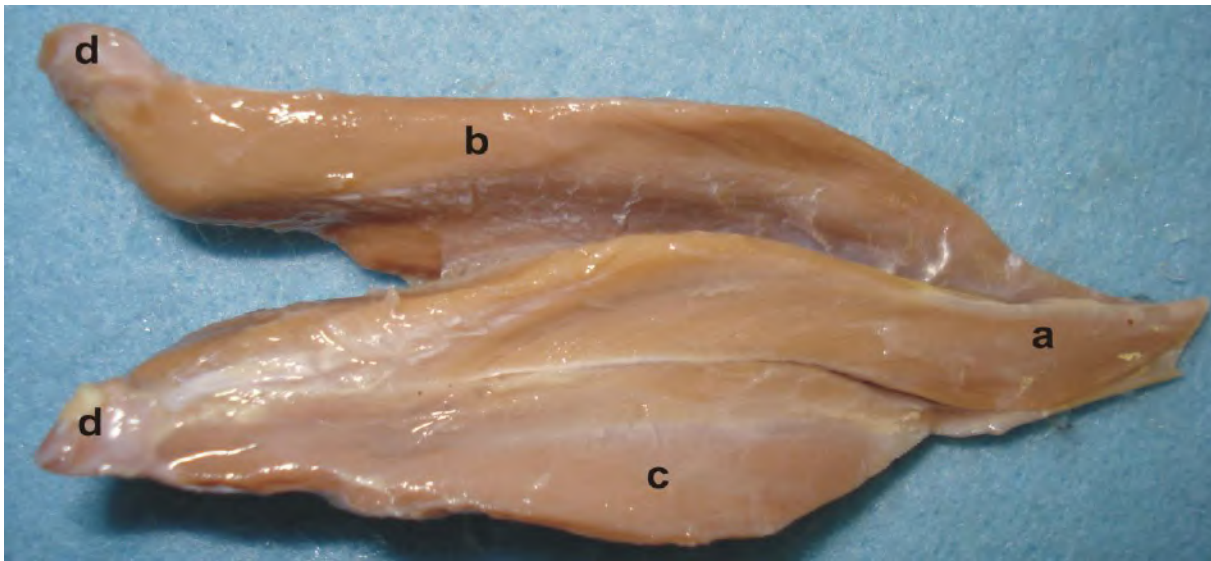


Fig.5: Photomicrograph of the coati leg: cranial view - a- superficial flexor digitorum, b, medial head of m. gastrocnemius, lateral head of the c m. gastrocnemius, d- sesamoid bones.

The aponeurosis of two lateral and medial heads fuses distally and then converges to form the single Achilles tendon that inserts at the end of the calcaneus. Superficial flexor muscle of fingers (MFSD) -The superficial flexor digitorum muscle was a long muscle, whose womb was surrounded by the heads of the gastrocnemius muscle. Proximal, medial and distal measurements were nearly identical: MFSD: Length = 6.9; Width = 0.9 and thickness = 0.6 cm and MFSE:

Length = 6.8, Width = 0.9 and thickness = 0.6 cm. The superficial flexor digitorum muscle had a common origin with the lateral head of the gastrocnemius muscle and its insertion was in the plantar aponeurosis, after crossing the calcaneus distally. It was surrounded by the gastrocnemius muscle bellies, except on the cranial aspect, when in contact with the m. soleus muscle (Figures 4 and 6).

Table 5: Morphometric measurements (cm) of superficial flexor muscle of the right fingers in Coati.

VENTRE	LARGURA				ESPESSURA				VOLUME
CV	PR	MM	DI	MD	PR	MM	DI	MD	VOL/cm ³
6,9	0,9	0,9	0,9	0,9	0,5	0,7	0,6	0,6	3,73

Table 6: Morphometric measurements (cm) of flexor surface of the left fingers in coati.

VENTRE	LARGURA				ESPESSURA				VOLUME
CV	PR	MM	DI	MD	PR	MM	DI	MD	VOL/cm ³
6,8	0,9	0,9	0,9	0,9	0,5	0,7	0,6	0,6	3,62

Soleus muscle: The raccoon had a relatively robust soleus muscle, whose approximate volume was around MSD = 4.2 cm³ and MSE = 3.41cm³. The lateral side was elongated and slightly flattened in appearance (Figures 4 and 6).



Fig.6: Photomacrograph of the coati leg: A- medial view, B- Side view: a- belly soleus, b- proximal fixation of the soleus, gastrocnemius tendon c-, d- calcaneus.

Table 7: Morphometric measurements of right soleus muscle in Coati.

VENTRE	LARGURA				ESPESSURA				VOLUME
	PR	MM	DI	MD	PR	MM	DI	MD	VOL/cm ³
6,0	1,2	1,7	1,2	1,4	0,4	0,4	0,6	0,5	4,20

Table 8: Morphometric measurements (cm) of left soleus muscle of Coati.

VENTRE	LARGURA				ESPESSURA				VOLUME
	PR	MM	DI	MD	PR	MM	DI	MD	VOL/cm ³
6,1	1,1	1,8	1,2	1,4	0,2	0,3	0,7	0,4	3,41

Soleus muscle is located in the leg, deep to gastrocnemius muscle. Its origin was in lateral aspect of fibular head, through a plan tendon and slender and intermuscular fascia. In the two proximal thirds, it was located in the intermuscular septum between it and superficial to the deep flexor digitorum longus muscle. Moving away from its origin in the distal direction, it became increasingly independent, with only fascial attachment to the flexor. The superficial surface was in contact with the gastrocnemius and tensor of plantar

aponeurosis (superficial finger flexor) muscles, though was completely separate from them. The distally insertion was at the end of the calcaneus, deep to the insertion of the gastrocnemius.

The volumetric values of each target muscle showed that the right muscles are relatively larger than the left ones, being more pronounced in the soleus muscle. The right muscle group had a relatively larger volume than the left one, showing asymmetry between the sides (Figure 7).

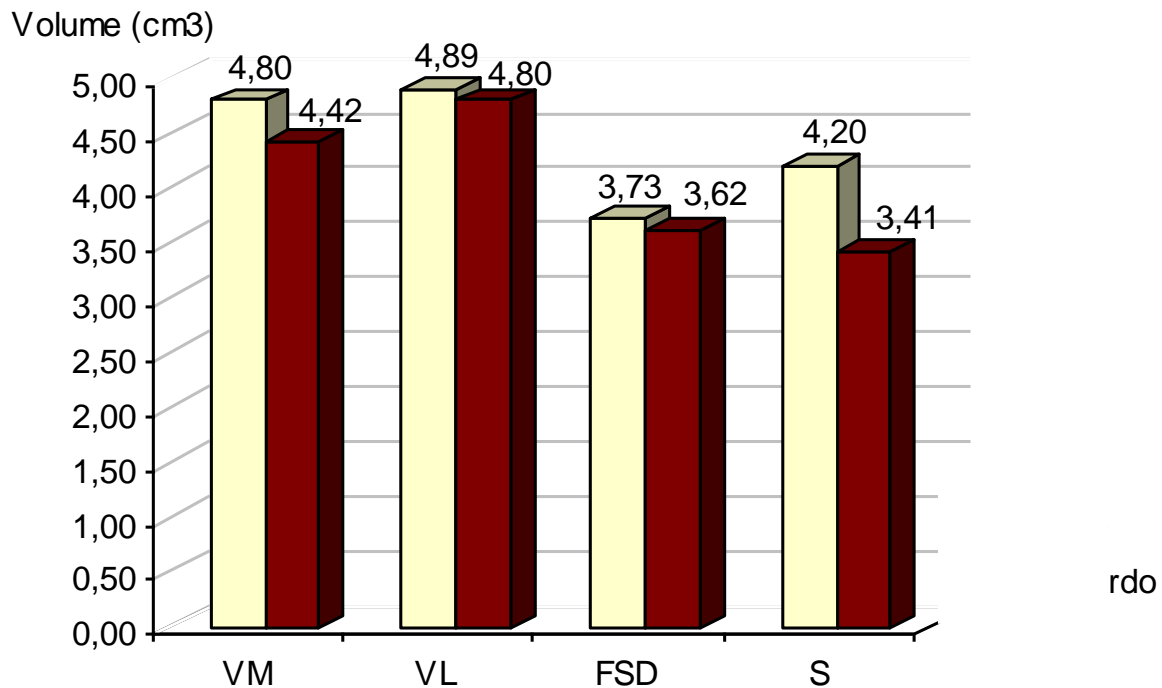


Fig.7: Volumetric values of muscles on the right and left sides of muscles Coati (*Nasua nasua*). MB = medial belly; SB = side belly; SFF = superficial flexor of the fingers; S = soleus.

IV. DISCUSSION

Gastrocnemius muscle is divided into medial and lateral heads in most species previously studied (MILLER, et al., 1964) in dog; (SCHÖN, 1968) in Bugio; (TESTUT et al., 1979), in humans; (HERMANSON et al., 1993) and (DYCE et al., 2004), in domestic animals; (GETTY, 2008) in pigs and carnivores [8-13]. The same was also identified in the present study performed in coati, where the gastrocnemius muscle was made up of two heads, one lateral and a medial. Also similar to other species, the proximal origin of the heads of gastrocnemius muscles was identified in the flexor aspect of the distal end of the femur, with a sesamoid bone included in the tendon of origin. Miller et al. (1964) reported that in the dog, originate from the plantar surface of the distal end of the femur by strong tendons, with a sesamoid bone that articulates with the femoral condyle. Schön (1968) described the origin of lateral head of gastrocnemius muscle to be located on lateral epicondyle of femur and knee joint capsule, with a fleshy origin of the medial head in the medial epicondyle [8-9]. Pérez-Arévalo et al. (2009) reported the gastrocnemius origin in rabbits in the medial and lateral condyles of the femur [14]. Testut et al. (1979) described human anatomy of the heads of the m. gastrocnemius originating at the distal end of the femur,

with each head set at the condyle by strong tendons. Sesamoid bones were not present at the origin, but instead a cartilaginous core was located in their place [10]. Getty (2008) indicated that in domestic carnivores, the heads of the m. gastrocnemius originate in the medial supracondylar spines and lateral femur by strong tendons that incorporate sesamoid bones [13].

The origin of gastrocnemius muscle by strong tendons that occurs in coati, and is elsewhere described in other species in the literature, suggests the importance of this muscle in the maintenance of posture and body movements, such as scaling trees. Despite the presence of sesamoid bones within tendons, which could minimize possible wear as they cross the knee joint and create lever arm loading that improves efficiency, the origin structures are subjected to great stresses and strength requirements in animals that run and jump. This does not occur in humans where the corresponding anatomical formations are cartilaginous or do not exist.

Raccoon is a sturdy animal with prominent arch support. This species is semi-arboreal that is quick to get around or climb trees, hence the need for powerful muscles that can provide needed strength. This can result in large torque on the knee and ankle in a short time. According to Camargo Filho (2006), the human

gastrocnemius muscle has a predominance of type II fibers (glycolytic) [15]. Moraes et al. (2007) described that this muscle has the capacity to develop great tension in a short time. It is therefore possible that the gastrocnemius muscle in coati has an equal predominance of glycolytic fibers, as they are very agile in climbing and get around well both in trees and on the ground. In domestic animals, the literature states that the two bellies of the gastrocnemius almost surround the superficial flexor digitorum muscle belly, a condition also observed in coati [16].

The gastrocnemius muscle in Coati is very robust relative to the length of the tibia and, therefore, the physical size of the animal. Coati had a gastrocnemius muscle of 10.0cm³ in the right antimer and 9.5cm³ on the left, with a tibia of approximately 8.6 cm and 8.5 cm respectively, equivalent to a medium-sized specimen (1.8–2.0 kg). The right muscle had a relatively higher volume than the left without a plausible explanation. Asymmetry was observed between the right and left sides, with the dimensions of the right muscle belly larger than the left. The small fleshy origin of raccoon gastrocnemius muscle could be a remnant of plant or popliteus muscle, since it was not identified anatomically in this taxon but is located in the same location. The proximal third of the gastrocnemius muscle was roughly cylindrical as in domestic animals, while the middle portion was wide and slightly flattened [8, 12-13]. According to Miller et al. (1964), in dogs, the medial head of the gastrocnemius is independent, while the lateral head is partially fused to the superficial flexor digitorum muscle belly. This condition was researched in domestic animals by Getty (2008): in human, by Testut et al. (1979). In other animals, the two heads are entirely separate. In coati, the medial belly is totally separate from the side belly and the superficial flexor digitorum muscle belly; however, the lateral belly and the superficial flexor digitorum muscle belly are partially fused throughout its length. On the cranial surface, only a groove marks the separation, while on the surface, two grooves are present between the belly of the flexor and both heads of the gastrocnemius [8, 10, 13].

Previous descriptions of the formation of the Achilles tendon and insertion on the end of the calcaneus support the assertion that the aponeuroses of the two heads of the gastrocnemius condense and combine to constitute the great Achilles tendon, since the flexor digitorum superficialis tendon in domestic dogs circumvents the Achilles tendon and distally opens in blade involving the distal part of the Achilles tendon and the end of the calcaneus bone, spreading into the plantar aponeurosis [8, 12-13]. This condition was also identified

in the raccoon, but the distal part of the Achilles tendon was joined by the soleus tendon, which is absent in the dog.

With regard to the soleus muscle, Testut et al. (1979) disclosed that, in humans, it has a similar shape of a shoe sole that is wide, thick and long, and located deep to the gastrocnemius. Its origin is the head of the fibula, tibia and proximal interosseous membrane. The origin is a tendon divided into three parts: peroneal, tibial and intermediate. The ramifications inherent in the source are just the tendon. Its insertion is at the end of the calcaneus, the deepest part of the Achilles tendon. Distally its tendon enters the Achilles tendon, a common occurrence in anthropoids [10]. Sometimes muscle fibers reach the calcaneus. According Dyce et al. (2004), the soleus muscle is absent in dogs, but developed in the cat, and as in horses, is a single structure extending from the fibula to the calcaneus. Getty (2008) reported that the soleus muscle was absent in dogs and developed in cats and pigs. In pigs, the soleus muscle is attached to the lateral head of the gastrocnemius, and its origin is at the lateral epicondyle of the femur and deep knee fascia. The insert is in the Achilles tendon [12-13].

Coati soleus muscle is quite robust, with an approximate volume of 4.2cm³ in the right antimer and 3.4cm³ on the left. It is located in the caudal part of the leg, deep to the gastrocnemius, and originates from the lateral aspect of the head of the fibula and the interosseous membrane. It also is fixed in the intermuscular fascia between him and the long deep flexor muscle of the fingers. Its distal third is free and inserts with the gastrocnemius. The plantar aponeurosis of the tendon of the tensor muscle runs beside the Achilles tendon. The presence of a strong soleus muscle appears to be associated with plantigrade stepping, which is well developed in humans and other primates. The origin of the soleus muscle is common with the origin of the lateral head of the gastrocnemius. After dissection and study the anatomy of the superficial flexor digitorum muscle, it seems likely that this muscle has no direct action on the fingers but on the plantar aponeurosis, acting indirectly to flex the fingers, at least in plantigrade animals.

V. CONCLUSION

The present study demonstrated that gastrocnemius muscle of Coati is robust with respect to physical size of this animal and compared with other mammals, were bellies of lateral and medial heads of gastrocnemius muscle of Coati almost entirely surround the belly superficial flexor digitorum muscle. In addition this work show that gastrocnemius muscles, soleus and

flexor surfaces of Coati fingers, are relatively larger in right antimer, than left antimer. The raccoon has a strong soleus muscle, similar to non-human primates. Our findings contribute to the description of an important muscle and best knowledge of Coati biological system.

REFERENCES

- [1] C. Oliveira, R. A. P. Teixeira, W. L. Conchalo (2004). Uma abordagem contextualizada da Anatomia Humana e Comparada. Instituto de Biociências, Letras e Ciências Exatas, UNESP, Laboratório de Anatomia Comparativa. São José do Rio Preto, pp. 291–310.
- [2] L. J. A. Didio, M. M. Amatuzzi, S. V. Cricente (2003). Sistema muscular. In: Di Dio Tratado de anatomia sistêmica aplicada. São Paulo: Atheneu, pp. 187-287.
- [3] S. N. Sano, S. P. Almeida (1998). Cerrado: ambiente e flora. Planaltina: Embrapa - CPAC.
- [4] J. Marinho-Filho, F. H. G. Rodrigues, K. M. Juarez (2002). The Cerrado mammals: diversity, ecology and natural history. In: The Cerrados of Brazil: Ecology and Natural History of a Neotropical Savanna. Oliveira PS and Marquis RJ. New York: Columbia University Press.
- [5] B. D. Patterson (2000). Patterns and trends in the discovery of new Neotropical mammals. 6, 145– 151.
- [6] M. Kamioka, M. Sasaki, K. Yamada, H. Endo, M. Oishi, K. Yuhara, S. Tomikawa, M. Sugimoto, T. Oshida, D. Kondoh, N. Kitamura (2017). Mobility of the forearm in the raccoon (*Procyon lotor*), raccoon dog (*Nyctereutes procyonoides*) and red panda (*Ailurus fulgens*). The journal of veterinary medical science, 79, 224–229.
- [7] International Committee on Veterinary Gross Anatomical Nomenclature. Nomina anatomica veterinaria. 6. ed. Rio de Janeiro: World Association on Veterinary Anatomist, 2017.
- [8] M. E. Miller, G. C. Chistensen, H. Evans (1964). Anatomy of the dog. Philadelphia: W. B. Saunders: 746.
- [9] M. A. Schön (1968). The muscular system of the red howling monkey. U.S. National Museum Bull. 273, 181-185.
- [10] L. Testut L, A. Latarjet (1979). Tratado de Anatomia Humana. Ed. Salvat.
- [11] J. W. Hermanson, H. E. Evans (1993). The muscular system: muscles of the pelvic limb. In: Evans, H. E. Miller's Anatomy of the dog, 3 ed. Philadelphia: W. B. Saunders, pp. 349-384.
- [12] K. M. Dyce, W. O. Sack, C. J. G. Wensing (2004). Tratado de Anatomia Veterinária – Ed. Elsevier. 2004.
- [13] R. Getty (2008). Anatomia dos animais domésticos. 5. ed. Rio de Janeiro: Guanabara Koogan.
- [14] M. L. Pérez-Arévalo, O. Morón-Fuenmayor, N. Gallardo, V. Vila (2009). Caracterización anatómica y física de los músculos del conejo. Revista Científica, 19(2), 134-138.
- [15] J. C. S. Camargo-Filho, L. C. M. Vanderlei, R. C. T. Camargo, F. A. Francischeti, W. D. Belangero, V. Dal Pai (2006). Efeitos do esteróide anabólico, nandrolona, sobre o músculo sóleo de ratos submetidos a treinamento físico através de natação: estudo histológico, histoquímico e morfométrico. Revista Brasileira de Medicina do Esporte, 12(5), 243-247.
- [16] F. B. Moraes F.B.; Paranaíba R. M.; De Oliveira E.; Kuwae M. Y.; Rocha V. L. Estudo anatômico do músculo gastrocnêmio medial visando transferência muscular livre funcional. Revista Brasileira de Ortopedia v. 42, n. 8, p. 261-265, (2007).

The Balance of Trade in virtual water in the Countries of South America

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Abstract—The aim of this paper is estimate the balance of virtual water trade of all the countries of South America with the rest of the world from 2003 to 2011. The South American continent is the region where is located the main rivers basins in the world. Virtual water trade is an application of water footprint, which is a concept derived of ecological footprint, which means the water used to produce goods and services, and those products are traded between countries. The data were retrieved from Food and Agriculture Organization and combined with data of specific requirement for water for each product. Using the quantities exported and imported products of the top twenty and data of specific requirement for water for each product (green water), was calculated the export and import virtual water in each country. The results highlight three different groups of South American countries and indicate that there is heterogeneity in the same virtual water trade for those countries.

Keywords—virtual water, South America, Green Water.

I. INTRODUCTION

It is well known that the amounts of water differ widely between countries, as well as all other natural resources, whether renewable or not. Taking this into consideration, Allan (1997) asks, referring mainly to the countries located in arid or semi-arid regions, the reason for the absence of war between them for access to water, because, as we know, these countries account for over half of water they need for their survival. The answer to this question, explains, comes from the so-called virtual water trade. This same response also appears to be relevant to another question: how could certain countries have a population growth over the availability of water existing in their territories?

The above questions are relevant, precisely because of increased population pressure on resources, and also because of the externalities that human activities generate on the environment, which mostly consist of negative. A second argument is given by Allan (1997, p. 4) that “the huge volumes of water utilized by agriculture are not counted as part of the national water budget. Such water is a free good”. Moreover, the concept of rule indicated by the weak sustainability of Hartwick (1977), that natural capital may be replaced by any other type of capital is far from being applied to the case of water. Therefore, even when water is a renewable resource, although finite, changes in availability and environmental impact on water quality, affecting their different purposes and, therefore, that the population uses it does.

The answer to both questions is grounded initially proposed the so-called virtual water trade. Virtual water is

the volume of water used to produce goods and services (Aldaya, Allan & Hoekstra, 2010). But the trade in virtual water can be understood as the amount of water used throughout the production process of an asset that is traded internationally.

Therefore, to measure and different flows of international trade through the monetary value becomes equivalent water. This is not to establish a complementary view to the measures in force measurement, but in an alternative way to understand the exploitation of natural resources, particularly water, which the traditional understanding of the economic models are purely neglected or are not adequately addressed. “Virtual water adds a new dimension to international trade, and brings along a new perspective about water scarcity and water resource management” (NOVO, GARRIDO, VARELA-ORTEGA, 2009, p. 1454).

In these sense, the aim of this paper is estimate the balance of virtual water trade of all the countries of South America with the rest of the world from 2003 to 2011. The South American continent is the region where is located the main rivers basins in the world, like the Amazon basin, La Plata and Orinoco, for instance, and accounts for about 25% of all freshwater on the planet. However, not all countries located there face situations comfortable in relation to water availability. Trinidad e Tobago is, for example, a country with the lowest water availability on the continent, about 3,130 m³ per year per person. Have other countries, like Argentina, Bolivia, Brazil, Chile, Colombia and Venezuela are faced with per capita amounts between 19,000 and 60,000 m³ per year per person. And Guyana,

whose abundance of fresh water is one of the largest in the world, is faced with more than 320,000 m³ per year per person. This means that water is, for the most countries in South America, an abundant resource and it offers opportunities to use in different ways, like transport, power generation or crops and livestock productions. Therefore, it is expected that the exports of high water endowment countries exceeds the imports of virtual water, featuring a surplus in virtual water. This study justify due the context of water scarcity, international virtual water trade can reallocate the production to countries with more available water. To address these questions, the paper covers, beyond the introduction, literature review, material and method, results and conclusion.

II. LITERATURE REVIEW

In the last years, there is a growing body of literature focusing on the concept of virtual water (HOEKSTRA AND HUNG, 2005; ALDAYA, ALLAN & HOEKSTRA, 2010, CHAPAGAIN AND HOEKSTRA, 2011). All these papers have emphasized the potential contribution to saving water and the appropriated use of it. And a special attention has been devoted to virtual water in international commodity trade, because "international trade can save water globally if a water-intensive commodity is traded from an area where it is produced with high water productivity (ton/m³) to an area with lower water productivity" (ALDAYA, ALLAN & HOEKSTRA, 2010, p. 887).

The interest in this subject is due agriculture and trade have the functions to serve humanity by eradicating hunger and poverty. Nevertheless, these functions "have recently been challenged by emerging forces including climate change, water scarcity, the energy crisis as well as the credit crisis" (Hanjra and Qureshi, 2010, p. 365).

Hanjra and Qureshi (2010) address the main challenges for water quality and quantity: decrease the competition for water between and within sectors; decrease inequity in water access; control the incidence of water borne diseases; keep natural conditions of freshwater ecosystems; diminish the tension over the use and control of water and its potential for conflict in different levels and control climatic conditions to avoid extreme wet and dry events.

Virtual water trade is based on evidence that "high water scarcity will make it attractive to import virtual water and thus become water dependent. One would logically suppose: the higher the scarcity within a country, the more dependency on water in other countries" (Hoekstra and Hung, 2005, p. 46).

Hoekstra (2008) states that the environmental footprint of water was originally introduced in 2002 and derives from

the broader concept of ecological footprint, which originated in the early 1990s. Thus, the ecological water is the amount of water (measured in cubic meters per year) needed to sustain the population. The concept of eco-paid water also relates to the "Human Appropriation of the earth's resources relates to the carrying capacity of the earth" (Hoekstra, 2008, p. 1964).

At this point, it is important to note the terminology used in water use (ALDAYA, ALLAN & HOEKSTRA, 2010). Chapagain and Hoekstra (2011) point out that the blue water refers to water that evaporates during the process of producing goods and services and that comes from surface water and groundwater. Green water is the volume of water which evaporates from rain water stored in the soil. And the gray water is the volume of water used in the production process and, after being used, was polluted.

Aldaya, Allan & Hoekstra (2010, p.887) say that, "green water generally has a lower opportunity cost than blue water. Even if it is more and more upheld that green water represents the largest share of virtual water in the international trade of agricultural commodities, with exports going from green water rich countries towards generally blue water based economies, hitherto, green water volumes have rarely been estimated".

Regardless of the availability or not of water, Pimentel (2004) states that the water use incorporated into human nutrition has increased significantly in recent years due to the change in food choices, especially for meat, which requires large volumes of water (Fraiture and Wichelns, 2010). And the consensus is that the change in food consumption patterns in countries with low abundance of water depends on the trade in virtual water. Hanjra and Qureshi (2010) analyzed the climate change, water scarcity, the energy crisis and population growth and how these forces redefining the global water supply and demand, specially on global food security.

In a globalized world, where the transactions are possible, all countries produce and export crops and livestock goods, as well processed and industrialized foods, like orange juice, preparations of beef meat, soybean oil and sugar confectionery, for instance. The exports depend on availability of natural resources and the production systems, and imports depend on the domestic demand and also the availability of natural resources.

An important consideration about the overuse of water was highlighted by Goswami and Nishad (2015, p1); these authors said that "estimates show that export of embedded water alone can lead to loss of water sustainability". They also predicted that, due to virtual water trade, India will lose its available water in less than 1000 years. This period can be considered a short time trend taking account the

entire history of India country. Goswami, Nishad, and Sushravya (2016) projected a declining trend related to water resources and the different uses of water have an increasing trend, such as agriculture, domestic, and industrial purposes for the next decades.

Water, among other resources, can be thought as a production factor, such as labor, capital or land; and the availability of these factors defines the pattern of the international trade. The Heckscher-Ohlin model (H-O model) explains the trade among the countries when the transactions are free and under the hypothesis that there are no transaction costs. The core of the HO model is that each country specializes in international trade in the good intensive in the factor of production. Extending the Ricardian model of international trade for various factors of production, the H-O model states that the specialization in trade is determined by the relative cost of factors of production (GANDOLFO, 1998). Thus, countries with abundant natural resources, will specialize and export goods intensive in these resources

The use of H-O model to explain the virtual water trade is adopted by some authors (Hoekstra and Hung, 2005; Guan and Hubacek, 2007). The main idea is that high water endowment countries export intensive water goods. In the other hand, Ansink (2010) uses the H-O model to refuse the two main claims about this subject: (i) virtual water trade levels uneven water distribution and (ii) virtual water trade reduces the potential for water conflict. The author complements that “both claims are based on an incorrect understanding of comparative advantage in the production of water-intensive goods. The results show that both claims only hold under certain conditions, but do not necessarily follow from the Heckscher-Ohlin trade model” (ANSINK, 2010, p. 2027).

The researches about this subject aim evaluate the virtual water exportation and importation and the balance of the trade. Aldaya, Allan and Hoekstra (2010), for instance, estimated the green and blue virtual-water content of maize, soybean and wheat exports for the main exporting countries of these crops (Argentina, Australia, Canada and the USA). Guan and Hubacek (2007) evaluated the Chinese inter-regional trade structure, using virtual water flows, and its effects on water consumption and pollution. Hanasakiet al. (2010) simulated the virtual water content of major crops consistent with their global hydrological simulation.

Papers on virtual water trade have focused on water quantity. Dabrowskiet. al (2009) investigated the impacts of water quality on virtual water trading. A proxy for water quality impacts was created by calculating the amount of water required to dilute nonpoint-source agrochemical

inputs to relevant water quality guideline values. The results suggest that in virtual water trading scenarios the impacts of agriculture on water quality need to be considered, due the “volume of water required for dilution is compared to the volumes of blue water used. The relative importance of water quantity and quality use is dependent on the specific water requirements of the particular crop” Dabrowskiet. al (2009, p. 1080).

Fraiture and Wichelns (2010) analyzed four scenarios taking account variations on investments in rainfed agriculture and irrigation. The most striking result to emerge from the study is that there are water and land resources available to supply global food demands during the next fifty years. The restriction is that only water is managed correctly and effectively in agriculture.

Guan and Hubacek (2007) evaluated the China inter-regional trade structure and its effects on water pollution and consumption using virtual water flows. The results point out that the domestic trade structure is misallocated and inefficiency. Novo, Garrido, Varela-Ortega (2009, p. 1454) showed that Spain is a “show that Spain is a net virtual water importer through international grain trade”, and it is consistent with relative water scarcity.

III. MATERIALS AND METHODS

Through the data on agricultural and livestock production retrieved from FAO were selected the top twenty exports and imports goods that generate the most value to the external accounts of every country in South America. Data were collected during the period covered the years 2003 to 2011 totaling thus nine years of observations. It is noteworthy that the top 20 products in 70.1% to 99% of all commercial transactions involving agricultural goods, which can be fresh, lightly processed or prepared for human consumption.

Using the quantities exported and imported products of the top twenty and data of specific requirement for water for each product (green water), was calculated the export and import virtual water in each country. Specific requirement for water data for crops were obtained from Mekonnen and Hoekstra (2010, a), and for farm animals and animal products from Mekonnen and Hoekstra (2010, b).

The methodology adopted in this study take account geographical location and water productivity for all countries analyzed. In this way, the virtual water export (VWE) of goods is expressed as follows:

$$VWE_{it} = \sum_{j=1}^m \sum_{i=1}^n q_{jit} w_{ji} \quad (1)$$

where q denotes the quantity of goods exported (crop, livestock goods and, processed and industrialized foods)

and w denotes specific requirement for water data for crops and animals and animal products. The subscripts j, i and t denote good, countries and year.

The virtual water import (VWI) of goods is expressed as follows:

$$VWI_{it} = \sum_{j=1}^m \sum_{i=1}^n q_{jit} w_{ji} \tag{2}$$

For a given year, the balance of virtual water (BVW) is the difference between virtual water export and virtual water import.

$$BVW_{it} = VWE_{it} - VWI_{it} \tag{3}$$

The results are explained below.

IV. RESULTS

Although South America has 14 countries, were considered for this study only 13. This difference is due to the fact that French Guyana is considered integral to the French territory, and whose statistics are not available in disaggregated form.

The Table 1 shows the area of all countries of South America totalizes 15.779.575 Km², in which Brazil, the largest country, has 53.9%. Argentina, the second largest, has about 2.78 millions of Km². In contrast, Trinidad and Tobago and Suriname are the smallest countries in South America.

Table 1: Total renewable water resources for country

	TOTAL RENEWABLE WATER RESOURCES km ³ /year	POPULATION	AREA (Km ²)	WATER AVAILABILITY PER PERSON (m ³ /person)	WATER AVAILABILITY PER AREA (m ³ /Km ²)
Argentina	814	42,192,494	2,780,400	19,292.53	292,763.63
Bolivia	622.5	10,290,003	109,858	60,495.61	5,666,405.72
Brazil	8233	199,321,413	8,514,877	41,305.15	966,895.94
Chile	922	17,067,369	756,102	54,021.21	1,219,412.20
Colombia	2132	45,239,079	1,138,910	47,127.4	1,871,965.30
Ecuador	432	15,223,680	283,561	28,376.84	1,523,481.72
Guyana	241	741,908	214,969	324,838.1	1,121,091.88
Paraguay	336	6,541,591	406,752	51,363.65	826,056.17
Peru	1913	29,549,517	1,285,216	64,738.79	1,488,465.75
Suriname	122	560,157	16,382	217,796.1	7,447,198.14
Trinidad e Tobago	3.84	1,226,383	5,128	3,131.15	748,829.95
Uruguay	139	3,316,328	176,215	41,913.83	788,809.13
Venezuela	1233	28,047,938	91,205	43,960.45	13,518,995.67

Source: FAO (total renewable water resources) and CIA (Population and Area)

The Table 1 also shows the quantity available of water in each country. To be comparable, the total of renewable water was pondered by population and area data. Taking

into account the water per person, we can see that Guyana is an exception, more than 320 thousands m³ of water available per person. Most countries have between 28

thousands of m³ and 65 thousands of m³ of water available. On the other hand, Trinidad and Tobago is the country which has less water available, about 3,131 m³ per person. With reference to the quantity of water per area, it is possible to see that Venezuela is the country which has the most availability water per area, about 13 millions of m³ per Km²., Suriname and Bolivia are the second and third countries which have most availability water per area (7.4 million of m³/Km² and 5.6 million of m³/Km², respectively). In contrast, Argentina has the less availability, approximately 290 thousand of m³ per /Km².

Table 2 shows the quantity of water embedded in the twenty products that were exported by each country from South America. The two main countries were Argentina and Brazil. The quantity of water available in Argentina is very different from Brazilian situation. While Brazil has a huge water resources, Argentina has about just 10% of Brazil, however, it was the second exporter country. The reason for that was, as discusses above, Argentina is the second largest country, and has great quantity of area available for agriculture and animals. Chile, Colombia and Venezuela have more water available than Argentina, but these countries export less than Argentina.

Table 2: Virtual Water Exportation of South America Countries (km³)

	2007	2008	2009	20	2007	2008	2009	2010	2011	Average
Argentina	101,25	100,78	121,78	121,74	157,31	148,85	111,37	148,68	157,69	129,94
Bolivia	5,02	5,25	5,39	5,79	5,61	5,02	6,53	5,65	5,32	5,51
Brazil	122,79	134,12	134,52	142,77	154,95	149,03	163,07	176,82	186,5	151,62
Chile	1,37	1,59	1,99	1,84	2,33	2,32	2,09	2,5	2,77	2,09
Colombia	10,62	10,89	11,6	11,09	12,4	12,64	10,37	8,03	8,8	10,72
Ecuador	5,47	5,89	6,4	6,48	6,61	6,7	8,54	7,93	10,46	7,16
Guyana	0,74	0,88	0,74	0,7	0,7	0,68	0,2	0,2	0,61	0,61
Paraguay	11,4	14,79	16,76	17,3	22	23	20,18	21,55	24,39	19,04
Peru	2,28	2,87	2,42	3,67	2,88	3,64	3,26	4,28	5,28	3,40
Suriname	0,03	0,04	0,06	0,05	0,06	0,07	0,04	0,1	0,05	0,06
Trinidad e Tobago	0,27	0,31	0,32	0,32	0,3	0,18	0,18	0,17	0,12	0,24
Uruguay	6,96	8,33	10,04	10,9	10,21	10,62	12,59	14,03	12,76	10,72
Venezuela	1,3	0,86	0,76	0,69	0,89	0,45	0,28	0,25	0,24	0,64

Source: Own elaboration

Economic theory shows that the most important variable that explains import is domestic income, which is influenced by population. In this way, is expected that populated country, as Brazil, have huge demand on

imports, and virtual water import as well. In fact, during the period analyzed, Brazil had higher level of import (Table 3). Curiously, Venezuela, which has the fifth population, was the second and Chile was the third.

Table 3: Virtual Water Importation of South America Countries (km³)

Country	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
Argentina	3.02	3.40	3.78	3.91	7.11	8.37	7.30	8.73	10.20	6.20
Bolivia	1.43	1.01	1.03	1.12	1.29	0.96	0.66	0.82	1.15	1.05

Brasil	20.15	14.43	14.69	16.54	19.51	18.76	16.32	24.79	30.63	19.53
Chile	7.29	7.58	8.24	8.82	11.30	9.63	10.65	16.18	19.23	10.99
Colômbia	6.98	7.31	8.13	9.50	9.79	9.94	5.50	6.63	9.67	8.16
Equador	2.09	2.40	2.55	2.74	2.93	2.84	2.27	2.59	3.82	2.69
Guiana	0.20	0.22	0.20	0.16	0.16	0.23	0.25	0.28	0.31	0.22
Paraguai	0.35	0.41	0.48	0.48	0.53	0.61	1.06	1.24	1.48	0.73
Peru	5.31	6.14	6.79	7.09	7.60	7.62	3.80	5.47	7.07	6.32
Suriname	0.19	0.18	0.18	0.18	0.19	0.16	0.28	0.28	0.32	0.21
Trinidad e Tobago	0.65	0.68	0.60	0.50	0.57	0.65	0.85	0.90	1.24	0.73
Uruguai	1.12	0.89	0.93	1.48	1.04	1.73	1.33	1.74	2.95	1.46
Venezuela	6.80	8.33	6.02	8.26	10.61	12.49	28.13	15.29	13.73	12.18

Source: Own elaboration

The difference between virtual water export and virtual water import results the balance. First of all, it is important clarify that the countries analyzed can be clustered in three

different groups. The first one is formed by Brazil and Argentina, which had had approximately the same surplus in virtual water trade (Table 4).

Table 4: Balance of Virtual Water Trade of South America Countries (km^3)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
Argentina	98.22	97.38	118	117.83	150.21	140.47	104.08	139.95	147.49	123.74
Bolívia	3.59	4.23	4.35	4.67	4.32	4.06	5.88	4.83	4.17	4.46
Brasil	102.64	119.69	119.83	126.23	135.44	130.27	146.74	152.02	155.86	132.08
Chile	-5.91	-5.99	-6.25	-6.98	-8.98	-7.31	-8.56	-13.67	-16.47	-8.90
Colômbia	3.63	3.58	3.46	1.59	2.61	2.7	4.87	1.4	-0.86	2.55
Equador	3.38	3.49	3.84	3.74	3.67	3.86	6.27	5.34	6.64	4.47
Guiana	0.54	0.65	0.54	0.53	0.54	0.45	-0.06	-0.07	0.3	0.38
Paraguai	11.04	14.38	16.28	16.82	21.46	22.39	19.12	20.31	22.92	18.30
Peru	-3.03	-3.27	-4.37	-3.41	-4.72	-3.98	-0.54	-1.19	-1.79	-2.92
Suriname	-0.16	-0.14	-0.12	-0.13	-0.13	-0.09	-0.24	-0.18	-0.27	-0.16
Trinidad e Tobago	-0.39	-0.37	-0.28	-0.18	-0.27	-0.47	-0.67	-0.72	-1.12	-0.50
Uruguai	5.84	7.44	9.11	9.42	9.17	8.89	11.26	12.29	9.81	9.25
Venezuela	-5.5	-7.47	-5.26	-7.56	-9.73	-12.03	-27.85	-15.04	-13.49	-11.55

Source: Own elaboration

In average, the largest surplus country is Brazil. Additionally, how can be seen, in 2011 Brazilian surplus reached the equivalent of 155.86 km³ of water. During the period analyzed, Argentina had, in average, surplus of 132.08 km³.

The second group is constituted by countries with small, but positive, surplus, as Bolivia, Colombia, Ecuador, Paraguay and Uruguay. The exception is Paraguay, which had, in average, a surplus of 18.3 km³. In 2011, the surplus of Paraguay was 23 km³.

Additionally, the third group is formed by countries that import more than export, yielding deficit. Five countries are in this group: Chile, Peru, Suriname, Trinidad and Tobago and Venezuela. What is interesting in this data is that Venezuela and Suriname are countries which have the most availability water per area, respectively, about 13.5

million of m³ per Km² and 7.5 million of m³ per Km² (Table 1). The explanation about Venezuela may be concerned with political decisions, including oil export dependence and, as consequence, a special kind of Dutch disease.

Table 5 exhibits the correlation between trade (export, import and balance) and countries characteristics. All the measures of trade are correlated with renewable water resources, population and area. Concerning with water available per person, the correlation is negative for all measures of trade. And with respect to water available per area, the correlation is negative taking account export and balance, and a positive correlation was found with. This means that water availability per area is not a decisive factor for trade, due the presence of others elements, such as domestic markets, for instance.

Table 5: Correlation matrix

	Export Average	ImportAverage	Balance Average
TOTAL RENEWABLE WATER RESOURCES km ³ /year	0.7045	0.8330	0.6324
POPULATION	0.8010	0.8297	0.7366
AREA (Km ²)	0.8839	0.7602	0.8336
WATER AVAILABILITY PER PERSON (m ³ /person)	-0.2592	-0.3407	-0.2202
WATER AVAILABILITY PER AREA (m ³ /Km ²)	-0.296	0.1259	-0.3122

Source: Own elaboration

The three figures below exhibits the evolution of trade balance from 2003 to 2011. Taking account the first figure, formed by Argentina and Brazil, the surplus has a tendency of increasing. The figure also shows in 2009 a huge decrease of surplus of Argentina. This signalizes the impact of international crises in Argentina export, diminishing its surplus.

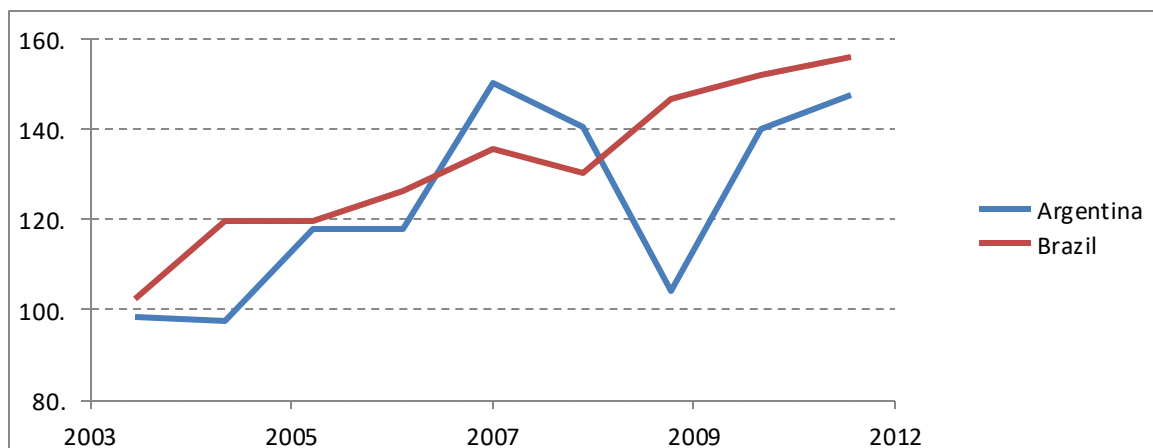


Fig.1: Surplus to the main countries on virtual water trade.

Source: Own elaboration

The second figure shows a clear tendency of increase of Paraguay and Uruguay surpluses. Colombia, had a small decrease, followed by a little increase and, after 2009, a severe decrease. The others countries (Ecuador, Bolivia and Guyana) keep moving at constant tendency.

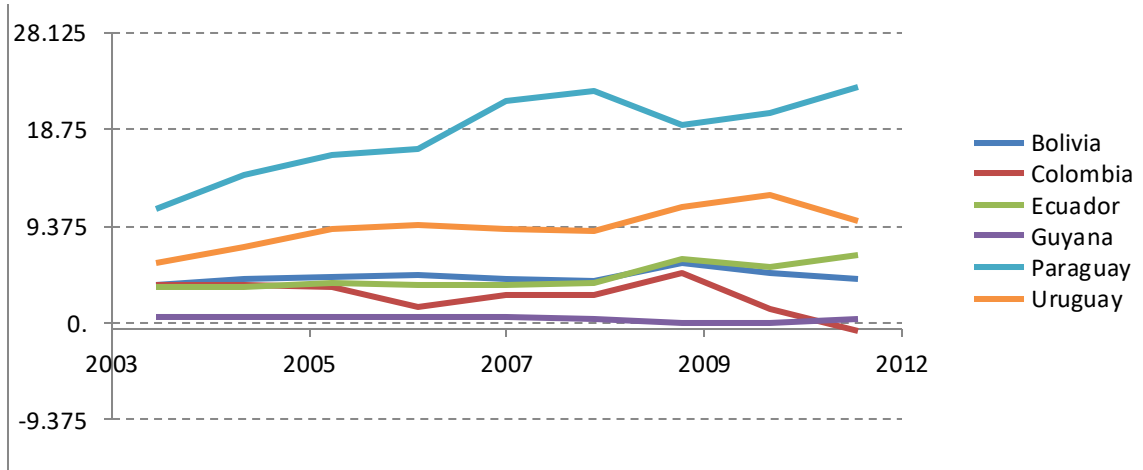


Fig.2: Surplus on virtual water trade.

Source: Own elaboration

And the third figure exhibits countries with deficits; this means that the level of import is bigger than export. Countries such as Suriname and Trinidad and Tobago face to small deficits. After 2009, Peru had diminished its deficit. And finally, Chile and Venezuela are countries

with huge deficits; and for both there are a tendency of increasing. The figure shows that Venezuela had a strong impact from international crises in 2009; but in 2011 it has recovered the same level in 2008.

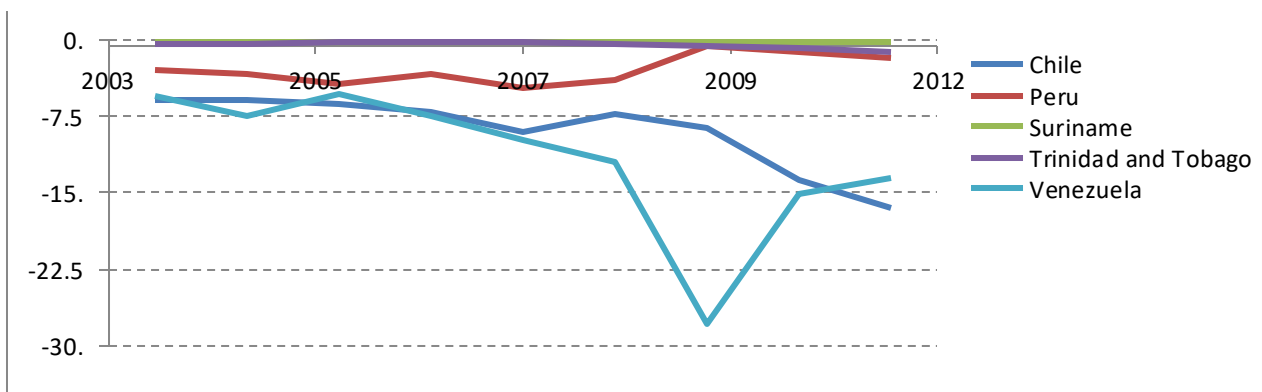


Fig.3: Surplus on virtual water trade.

Source: Own elaboration

V. CONCLUSION

The results indicate that there is heterogeneity in the same virtual water trade for those countries with abundance, as is the case of Venezuela, which should be a surplus, as shown by the theoretical assumptions of the H-O Model and the great quantity of water available. In this sense, the results not refute Ansink (2010) arguments.

Furthermore, taking account proportions, Brazil, which, given their territorial and climatic conditions, should

provide the highest surplus of the continent is behind Argentina, whose water availability and other resources is lower than the Brazilian case. In a way, this shows that Argentina uses resources more intensively than Brazil.

The growth of world income has a positive impact on demand for food requires intensive water and the producing countries, both in quantity and composition, more use of their water sources. Even water being a renewable resource, this feature depends on a broad and

complex set of other environmental services that are increasingly committed to the advancement of economic activities on other natural resources, such as the conversion of forest areas into agricultural systems. The absence of certain services environmental causes the water from becoming poor and inappropriate for certain uses. Moreover, the water lends itself to many purposes, and having exhausted their capacity for renewal, all-purpose, economical or not, become compromised, affecting significantly the very conditions of life of local populations.

REFERENCES

- [1] Allan, J.A. (1997) "Virtual water': A long term solution for water short Middle Eastern economies?' Occasional Paper 3, School of Oriental and African Studies (SOAS), University of London.
- [2] Aldaya, M.M., Allan, J.A., and Hoekstra, A.Y. (2010) Strategic importance of green water in international crop trade, *Ecological Economics*, 69(4): 887-894
- [3] Ansink, E. (2010) Refuting two claims about virtual water trade. *Ecol Econ* 69(10):2027–2032.
- [4] Chapagain, A.K. and Hoekstra, A.Y. (2011) The blue, green and grey water footprint of rice from production and consumption perspectives, *Ecological Economics*, 70(4): 749-758.
- [5] Dabrowski, J.M.; Murray, k; Ashton, P.J. and Leaner, J.J. (2009) Agricultural impacts on water quality and implications for virtual water trading decisions. *Ecological Economics*, 68: 1074 – 1082, 2009.
- [6] Fraiture, C. and Wichelns, D. (2010) 'Satisfying future water demands for agriculture', *Agricultural Water Management*, vol. 97, no. 4, pp.502–511
- [7] Gandolfo, G. (1998). *International Trade Theory and Policy*. Springer, Berlin.
- [8] Guan, D. and Hubacek, K. Assessment of regional trade and virtual water flows in China. *Ecological Economics*, 61 (2007) 159–170.
- [9] Guan, D. and Hubacek, K. (2007). Assessment of regional trade and virtual water flows in China. *Ecological Economics*, Vol. 61, No. 1, pp. 159–70.
- [10] Goswami P. and Nishad S. (2015) Virtual Water Trade and Time Scales for Loss of Water Sustainability: A Comparative Regional Analysis, *Scientific Reports*, 5 (9306), pp.1-11.
- [11] Goswami, P., Nishad, S, and Sushravya, H .M. (2016) Assessment and Projection of Water Demand in Changing Scenarios for India. *RUAS-SASTech Journal*. Vol. 16, n. 1.
- [12] Hanjra, M. and Qureshi, M. (2010) Global water crisis and future food security in an era of climate change, *Food Policy*, 35, 365–377.
- [13] Hartwick, John M. 1977. Intergenerational Equity and the Investing of Rents from Exhaustible Resources. *American Economic Review* 67 (5):972–74.
- [14] Hoekstra, A.Y., Hung, P.Q., 2005. Globalisation of water resources: international virtualwater flows in relation to crop trade. *Global Environmental Change* 15, 45–56.
- [15] Hoekstra, A.Y. (2008) Water neutral: reducing and offsetting the impacts of water footprints, *Value of Water Research Report Series No. 28*, UNESCO-IHE, Delft, the Netherlands.
- [16] Mekonnen, M.M. and Hoekstra, A.Y. (2010) The green, blue and grey water footprint of farm animals and animal products, *Value of Water Research Report Series No. 48*, UNESCO-IHE, Delft, the Netherlands.
- [17] Mekonnen, M.M. and Hoekstra, A.Y. (2010) The green, blue and grey water footprint of crops and derived crop products, *Value of Water Research Report Series No. 47*, UNESCO-IHE, Delft, the Netherlands.
- [18] Novo, P., Garrido, A., Varela-Ortega (2009) Are virtual water “flows” in Spanish grain trade consistent with relative water scarcity?. *Ecological Economics*, 68: 1454–1464.
- [19] Pimentel, D. et al. (2004) *Water Resources: Agricultural and Environmental Issues*. Bioscience, v. 54 n. 10, p. 909-918, Out.

Analysis of the Objectives of a Sustainable Use Conservation Unit: Application of the "Objectives Module" of the RAPPAM Method - Rio Ouro Preto Extractive Reserve

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Abstract— This study examines the following problem: “What does the management plan (conservation management document) indicate about the objectives of a conservation unit (CU), according to indicators in the 'Module - Objectives' from the RAPPAM method - world reference in evaluating the effectiveness of CU management?” The goal is to characterize the “objectives” of a sustainable use CU based on 8 indicators from the RAPPAM method. The study was applied to the Rio Ouro Preto Extractive Reserve, located in the Amazon. Some results deserve to be highlighted: the indicator “biodiversity” being absent in the objectives of the plan harms the CU in its master function: sustainability; the indicators “plans” and “projects” showed a wealth of detail; the indicators “employees”, “managers” and “policies” revealed a frightening reality: a lack of human resources; the indicator “local communities” revealed satisfactory participation. The management plan was deficient with its main objectives: strategic ones. They are of great importance because they are considered the highest priority according to the needs of the community. The study suggests a readjustment of the objectives, under penalty of undermining the objectivity of the management plan and sustainable development of the Exres. The study allows for the application of the method in other CUs, since all management plans have “objectives” in their textual structure. The scientific relevance of this study is justified in view of the sustainability of other CUs, since the management plan, as well as the objectives contained in the textual structure of the document, are common to all.

Keywords— Management Effectiveness. Management Plan. Sustainability. Objectives of Sustainable Use CU.

I. INTRODUCTION

This study analyzes the objectives of a federal sustainable use conservation unit (CU), in the state of Rondônia, northern Brazil, the Rio Ouro Preto Extractive Reserve (ROP EXRES). The objectives of an area destined for environmental protection should be established according to the natural resources that it has, since they are the main motive for which action is established to protect and preserve a certain area, like sustainable use conservation units.

Due to the importance of sustainable use conservation units, not only for Brazil but for the world, the objectives set out in the management plans of these types of conservation units should consider the broader scope, in order not to leave gaps in their intended actions. In order to be as complete as possible, a viable guideline

is to think of goals that include at least three segments: environmental, social and economic. In the case of extractive reserves, such as the Rio Ouro Preto Extractive Reserve, located in the Brazilian Amazon, a sustainable use conservation unit, the objectives take on an even greater proportion, because they have distinct characteristics, are unique, and are only found in Brazil. Although they are relatively small areas, EXRES can influence and interfere with the environmental dynamics of the entire planet.

The objectives of ROP EXRES are important, not only for environmental protection across the globe, but to promote the well-being of society in general and the local community, composed of people called “extractivists”. These people, in turn, will also be affected by the way the

unit is run. The objectives are thus decisive for the future of the globe, the extractivists and humanity as a whole.

This study seeks to answer six (6) questions about the “objectives” of the CU and characterize these objectives related to eight (8) indicators found in the RAPPAM method questionnaire, namely:

- 1) Protection;
- 2) Conservation;
- 3) Biodiversity;
- 4) Plans and projects;
- 5) Employees and managers;
- 6) Policies;
- 7) Local communities;
- 8) Management Board.

The above indicators were identified in Module 6 – “Objectives” of the RAPPAM method questionnaire which comprises the following questions:

- a) Do the PA objectives provide for the protection and maintenance of biodiversity?
- b) Are specific biodiversity-related objectives clearly stated in the management plan?
- c) Are management policies and plans consistent with the PA objectives?
- d) Do PA employees and administrators understand the PA objectives and policies?
- e) Do local communities support the overall objectives of the PA?
- f) Do the members of the PA’s management board understand the objectives and policies of the PA?

The above questions were taken from a global method for evaluating the effectiveness of protected area management, used in Europe, Asia, Africa, Latin America, the Caribbean and other locations: the “Rapid Assessment and Prioritization of Protected Area Management” (RAPPAM) method. The questions were answered from the document entitled “Rio Ouro Preto Extractive Reserve Management plan/RO – 2014”, which is the largest legal framework establishing the management of ROP EXRES.

In a statement, on May 10, 2017, WWF-Brazil reported on its official webpage that RAPPAM had already been used in more than 250 state conservation units and 292 federal conservation units in Brazil alone. The data indicate that throughout Brazil more than 80% of CUs are assessed using this tool (WWF-BRAZIL, 2017).

The theoretical construction was based on the following problematization:

Importance of a CU’s objectives – What does the management plan indicate about the objectives of a CU, according to the indicators from the “Objectives Module”

of the RAPPAM method – world reference for evaluating the effectiveness of protected area management?

The management plan for ROP EXRES was designated as the sample object of study to represent the problem. Since then, the problem studied has presented the following question: “What does the 2014 ROP EXRES Management Plan “indicate about the objectives of this unit, according to the 8 indicators in the “Objectives Module” of the RAPPAM method?”

The study is of utmost importance since ROP EXRES is in the midst of its first management plan created in 2014, which instituted a Management Agreement including “strategic objectives” set to take effect in the five-year period between 2014 and 2018, after which it was supposed to go through re-elaboration and reevaluation. The reworking of these objectives can include, based on the results of this study, the following aspects of the strategic objectives of the management plan:

- a) objectives that need to be improved, supplemented or restated;
- b) objectives that need to be deleted;
- c) new objectives that can be included;
- d) objectives that can remain the same as they have proven to be effective.

Thus, this study is justified scientifically to be able to contribute to the analysis of all involved in the process of updating the ROP EXRES management plan, as well as other management plans for other CUs, mainly because it is a thematic refocus linked to all the modalities of a CU: the “objectives”.

The benefits of the study are justified by the care taken to preserve the environment, which largely affect not only the global population, but also the physical environment of the planet Earth. It will, therefore, apply to the survival of life on the planet and preservation of the globe itself.

The presentation of the study is organized in order to characterize the object of study, in order to contextualize its location, its creation and the current situation as well as to show its current and future needs. Discussions follow about the objectives that serve as a guideline for conducting the analysis, namely those related to the 8 indicators referenced by the RAPPAM method.

The source and the operating dynamics of the RAPPAM method are also explained throughout the developing text. The text is noteworthy because it is based on an international parameter adopted by most countries that are dedicated to preserving conservation units across the globe.

II. METHODOLOGY

Since the ROP EXRES management plan has been in place for only four years (start of term: 2014), this study analyzed the characteristics of ROP EXRES objectives present in the management plan of this CU, because it is one of the most important elements of this protected area. The authors sought answers to the questions from "Module 6 - Objectives" of the RAPPAM method, throughout the document entitled "Rio Ouro Preto Extractive Reserve/RO Management plan", since the document is the legal framework in which the goals of linked to ROP EXRES should be contained.

The study analyzed the goals of one of the most important protected areas in the Amazon region in Brazil: ROP EXRES. As a federal unit, its location deserves attention since it's located in the border area between Brazil and Bolivia, suggesting possible invasion, exploitation and pillaging of its environment; also, this unit was one of the first protected areas created in Brazil (03/13/90), more specifically the fourth of its kind. The first was the Alto Juruá EXRES (Acre - on 01/23/90); the second was the Chico Mendes EXRES (Acre - on 03/12/90) and third was the Cajari River EXRES (Amapá - on 03/12/90).

The theoretical construction was based on the following questioning: What does the ROP EXRES "Management Plan - 2014" indicate regarding the objectives of this unit, according to the 8 indicators in "Module 6 - Objectives" of the RAPPAM method?

The methodology used to produce the data gains its theoretical basis in the foundations of Goncalves (2007). According to the author, a study can be classified according to the segments that structure it:

- a) its objectives;
- b) its data collection procedures;
- c) its sources;
- d) the nature of the data collected.

Thus, this study is embodied in the following classifications:

2.1 According to its objectives, this is a - Descriptive Study

According to the objectives of this study it presents itself as descriptive because its object of study is detailed by descriptions. The analysis is not exhaustive, but it objectively explores a descriptive presentation of the object of study in question.

This type of study is responsible for updating the reader on a particular object of study, about which little information is previously known. In this sense, a description of the object's characteristics is extremely

useful since it produces data that contributes to other types of analyses, which would not be possible without having first occurred a description of the phenomenon.

In this study the object to be described is the objectives of the CU ROP EXRES according to its 2014 management plan, in light of the questions present in the RAPPAM method questionnaire, specifically six (6) questions from Module 6 entitled "Module 6 - Objectives".

2.2 According to its data collection procedures this is a - Documentary Study

The procedures used to produce data in this study were based on the following steps:

Step 1 - Documentary study 1 (one) entitled:

Document 1: "Rio Ouro Preto/RO Extractive Reserve Management Plan- 2014" to identify all the parts of the plan that address the objectives ROP EXRES;

Step 2 - further studies on documents two (2) and three (3) entitled:

Document 2: "Effectiveness of Federal Protected Area Management - comparative evaluation of applications of the RAPPAM method in federal conservation units in cycles from 2005 to 2006 and in 2010 - Full version of the report - February 2012;

Document 3: Management Assessment of Protected Areas: RAPPAM (2015) and SAMGE methods (2016).

Step 3 - application of "Module 6 - Objectives" from the RAPPAM method questionnaire: search for answers in the aforementioned document 1, the management plan, guided by the 8 (superscript bold below) indicators found in the survey questions from the RAPPAM method:

- a) Do the goals of the CU include **protection¹** and **conservation²** of biodiversity?
- b) Are the specific objectives related to **biodiversity³** clearly stated in the management plan?
- c) Are the **plans** and **projects⁴** consistent with the goals of the CU?
- d) Do the CU's **employees⁵** and **administrators⁵** understand the objectives and **policies⁶** of the CU?
- e) Do the **local communities⁷** support the goals of the CU?

f) Do the members of the CU's **management board⁸** understand the objectives and policies of the CU?

Step 4 - description of the solutions found in the PA's management plan regarding the objectives of ROP EXRES through the development of a subsection for each question (Part 1/2 of this article);

Step 5 - record, along with the description of the previous step, of external theoretical contributions to the Management Plan (books, papers, theses, dissertations) in

order to compare the data obtained (Part 2/2 of this article).

Since 4 of the 5 steps outlined above are based on the study and use of institutional documents, called primary sources, i.e., official publications produced by government agencies or organizations in general, in order to predominate the primary sources in data surveys, it is said that this type of study is documentary research.

2.3 According to the sources of information this is a – Documentary Study

Based on the same reasoning set forth in the previous paragraph, this study is outlined as documentary research, due to the fact that the sources from which the data were extracted are original publications from institutional bodies. In this case, the data obtained from the ROP EXRES management plan, was thus processed and analyzed because it constitutes the official document in which the Management Agreement between all parties involved in this CU is found.

2.4 Based on the nature of the data this is a - Qualitative Study

Finally, the data collected acquire one of two possible definitions, according to the nature thereof: they are either defined as quantitative or qualitative data.

Quantitative data refers to those that are intended to characterize experiments numerically, statistically or through percentages, and assign them values in order to present numeric order in the data. Another allocation of quantitative data is that they are used to infer the cause of the phenomena; therefore, experiments are handled in a controlled manner through which hypotheses and their variants are tested as many times as is needed in order to prove validation of the results.

In turn, qualitative data is data concerned with interpretation of the phenomenon, in order to establish relations between it and the means through which it comes about, or in order to establish relations between the understanding that people have of the phenomenon and the medium in which it is inserted.

Based on the previous paragraph, this study is defined as qualitative research taking on a hermeneutic approach, where interpretations are made about the contents and principles present in legal texts, in this case in particular, the legal document entitled "2014 Rio Ouro Preto Extractive Reserve Management Plan /RO".

In the ROP EXRES management plan what the community and those involved in its formulation put in the text was the meaning of their practices in relation with this CU. This is in line with a qualitative study.

2.5 About the RAPPAM method:

Concerned about degradation in protected areas, the IUCN created the World Commission on Protected Areas (WCPA); in 1995, the committee brought together researchers in various specialties to obtain as much information as possible in order to develop guidelines aimed at environmental protection. With the information obtained a framework was established that served as a reference for the development of various methods of evaluation of the management of protected areas, taking into consideration three main aspects: a) planning; b) implementation b) evaluation.

Based on this framework the World Wide Fund for Nature (WWF) developed the Rapid Assessment and Prioritization of Protected Area Management (RAPPAM), a tool designed to assist managers of protected areas. It identifies the strengths of the units as well as their weaknesses that need to be improved by managers, through a fast and efficient evaluation. Managers, based on the analysis of these points may develop appropriate public policies for the protection of natural resources in the units.

Administration of a natural area requires the effort and dedication of those who are working directly or indirectly towards its development, and since it is an area of great importance, it draws the attention of institutions around the world like WWF. The concern to protect and conserve biodiversity is not just present in Brazil but around the world, it is currently a theme for international Congresses and scientific studies; this concern has gotten the attention of authorities, local leaders and NGOs such as WWF which is integrated in the same network as WWF Brazil. WWF Brazil is part of one of the largest environmental conservation networks in the world, seeking to minimize the negative impacts of human activities through the protection of biological diversity within the Brazilian territory.

With the support of universities, NGOs and other institutions, WWF Brazil contributes to the development of the country, developing projects since 1996, the year of its creation. It includes among its operating axes projects fighting against environmental degradation and towards the development of alternatives to reverse this problem. In this context, protected areas play a key role (WWF, 2012).

Since the year of its creation in 2002, and because of the good results obtained, the RAPPAM method has already been applied in over 50 countries, in protected areas of Europe, Africa and other continents. Its application was first performed in Brazil in 2004, to evaluate the effectiveness of some protected areas:

Ribeira Valley, Paraíba Valley, Serra da Mantiqueira, Upper Paranapanema and the metropolitan area of the capital, located in the state of São Paulo. But it wasn't until 2005 that it was applied in federal units in the Amazon.

Between 2005 and 2006 it was possible to apply the RAPPAM method for the first time in federal conservation units, located in the Amazon region, through a partnership established between WWF Brazil and IBAMA, the body responsible for managing the units prior to the creation of ICMBio. ROP EXRES was evaluated using the RAPPAM method in the three cycles during which the method was applied in Brazil: in 2005, 2010 and 2015.

Evaluation of management effectiveness as proposed in the RAPPAM method seeks to show that the actions taken meet the needs of the evaluated protected areas in order to ensure that its objectives are achieved. The method's questionnaire is based on five elements of the planning, management and evaluation cycle (context, planning, inputs, processes and results); each element is composed of specific topics covered in different themed modules. The following table clearly shows how each topic is constituted:

Table 1 - Structure of the RAPPAM questionnaire

Elemento	Módulo temático
Contexto	1. Perfil
	2. Pressões e ameaças
	3. Importância biológica
	4. Importância socioeconômica
	5. Vulnerabilidade
Planejamento	6. Objetivos
	7. Amparo legal
	8. Desenho e planejamento da área
Insumos	9. Recursos humanos
	10. Comunicação e informação
	11. Infraestrutura
	12. Recursos financeiros
Processos	13. Planejamento
	14. Processo de tomada de decisão
	15. Pesquisa, avaliação e monitoramento
Resultados	16. Resultados

Source: WWF-Brazil, 2012, p. 12.

The RAPPAM survey, based on CMAP, is divided into five (5) elements, namely: a) context; b) planning; c) inputs; d) processes and e) results. Each questionnaire element is directed towards specific areas called thematic modules; each thematic module consists of questions

about the reality of the protected area. Responses are applied to employees and the community involved with the protected area. That way a sense of the unity of the state of development is ascertained, through analysis and discussion of the modules.

The RAPPAM method evaluates the management effectiveness of protected areas and has a mathematical formula to calculate the index of this effectiveness. Since management is not the focus of this study the details of this calculation will not be described herein. This study aims to analyze the objectives of ROP EXRES. The questions contained in the RAPPAM method questionnaire were used for this purpose, because it is a method that is recognized worldwide and because it analyzes basic elements related to protected areas.

In the structure of the RAPPAM questionnaire, the "Planning" element contains three thematic modules, namely:

- a) Module 6 - Objectives;
- b) Module 7 - Legal Support &
- c) Module 8 - Design and planning of the area.

The theme found in module 6 - "Objectives" was chosen as the central focus of this study; this module, in turn, addresses the following questions:

- a) Do the PA's objectives include protection and conservation of biodiversity?
- b) Are there specific objectives related to biodiversity clearly stated in the management plan?
- c) Are the plans and projects consistent with the goals of the CU?
- d) Do the CU's employees and directors understand the objectives and policies of the CU?
- e) Do local communities support the goals of the CU?
- f) Do the members of the CU's management board understand the objectives and policies of the CU (2010 only)?

In section 3, all the kinds of goals found and identified in the ROP EXRES Management Plan will be described, along with the context of their creation, and the historical period in which they were formulated. The way they are described in the Management Plan can interfere with the interpretation and understanding thereof, as witnessed at the conclusion of the analyzed data. The analysis leads to the conclusion about how it is necessary to pay attention to the quality of the presentation of the Management Plan's objectives. A presentation devoid of clear and objective language prevents assimilation of the objectives and compliance with them, damaging the sustainability of the CU.

III. DESCRIPTION OF THE OBJECTIVES OF ROP EXRES PRESENT IN ITS MANAGEMENT PLAN

In the analysis of the ROP EXRES management plan six (6) types (categories) of objectives were identified in the document:

- a) **specific objectives** related to the CU ROP EXRES;
- b) a **general objective** regarding the general program "Environmental and Socioeconomic Sustainability Programs " (PSAS) of the Unit;
- c) "**common**" **objectives** for the programs contained in the aforementioned general program;
- d) "**common**" **objectives** referring to the sub-programs that make up the overall program;
- e) "**common**" **objectives** for the "Management Agreement";
- f) **strategic objectives** relating to the subprograms (as cited in "d" above).

The amount of objectives varies greatly and the chain of creation and redesign thereof is between the years 1990 and 2013. New adjustments and updates of the objectives are planned for the year 2019.

Altogether, 53 (fifty-three) goals are present in the 2014 ROP EXRES management plan, which are thus distributed according to their categories and formulation dates:

- a) five (05) **specific objectives** related to the CU ROP EXRES formulated at the time that ROP EXRES was established on 03/13/1990;
- b) one (01) **general objective** related to the general program of PSAS formulated through participatory workshops in 2009 and also reformulated in a workshop held in April/2013;
- c) 04 (four) "**common**" **objectives** referring to 05 (five) programs contained in the aforementioned general program. Preparation: participatory workshops in 2009; Update: Workshop in April/2013;
- d) 21 (twenty-one) "**common**" **objectives** referring to the 21 (twenty-one) subprograms contained in 05 programs that shape the overall program. Preparation: participatory workshops in 2009; additions: Workshop in April/2013;
- e) two (02) "**common**" **objectives** for the "Management Agreement" formulated at the general meeting on August 29 & 30, 2010;
- f) twenty (20) **strategic objectives** related to the subprograms ("d" above). Elaborated at the Participatory Planning Workshop in April/2013.

Regarding the formulation of objectives found in the Management Plan it can be said that preparation of the six (6) types always counted on the participation of internal members of the CU: residents and the local community

(sometimes only parents live in the reserve, while their children live in the city). The intervention of external members refers to agencies and institutions directly and legally linked to the management of extractive reserves, such as ICMBio. One external member to ROP EXRES who is contained in the management plan is registered as a consultant: Dr. Simone Vieira de Campos. The following sections contain descriptions of the objectives found therein:

3.1 Specific objectives concerning the CU ROP EXRES

The first objectives included in the management plan are the specific objectives of ROP EXRES as a whole. These objectives were first recorded in the 2014 management plan for the reserve. They were attained from the memories and oral contributions of residents of the Exres in a workshop held in April/2013, entitled Participatory Workshop (BRAZIL, 2014, p. 137). These objectives date back to the time when the Exres was created on 03/13/1990; however, this data was not included in any document until the management plan was published in 2014.

The specific objectives appear two (02) times in the 2014 ROP extractive reserve management plan, on pages 17 and 137. Altogether there are five (05) specific objectives:

- a) Ensure free work area for the extractivists with no bosses;
- b) Avoid invasions in the extractive reserve;
- c) Preserve the native forest;
- d) Ensure the sustainable use of natural resources;
- e) Promote access to education and health care for beneficiaries.

Despite them being defined as "specific", they could have been recorded as "general", since they refer to the CU as a whole.

3.2 General objective concerning the general program "Environmental and Socioeconomic Sustainability Programs of the Unit (PSAS)"

Section 4 (four) of the ROP EXRES management plan is entitled: "Contents of the Management Plan: Management Unit" and is made up of eight (8) sub-sections, namely:

- 4 Contents Management plan: Unit Management
 - 4.1 Unit management structure;
 - 4.2 Necessary infrastructure;
 - 4.3 Management agreement;
 - 4.4 EXRES zoning;
 - 4.5 Proposal for a buffer zone;
 - 4.6 Scenarios;
 - 4.7 Environmental and socioeconomic sustainability programs;

4.8 Strategic Planning.

The 2014 Management Plan indicates that ROP EXRES has a "general program" (item 4.7 above) consisting of five programs subdivided into 21 sub-programs designed to meet the needs of the community and the reserve. The overall program, its 5 programs, and 21 subprograms originated due to demand and the EXRES's potential, which were detected during the construction process of the Management Plan itself.

Subsection 4.7 of Section 4 of the Management Plan, p. 123 contains the general program called PSAS with the following objective: "It aims to promote environmental conservation, sustainable management of natural resources, value culture and improve the quality of life of traditional populations" (BRAZIL, 2014).

3.3 "Common" objectives referring to the programs contained in the aforementioned general program

According to the Management Plan, the general program entitled PSAS is divided into five (5) programs:

- a) Quality of Life and Citizenship Program;
- b) Natural Resources and Supply Chains Management Program;
- c) Degraded Areas Recovery Program;
- d) Environmental Monitoring and Protection Program;
- e) Management and Administration Program.

Each of the five (5) programs has its own objectives, except for the "Management and Administration Program", for which no objective is recorded in the 2014 ROP EXRES management plan document. The objectives are:

- a) Quality of Life and Citizenship Program
objective: To value culture and improve the quality of life of traditional Exres populations.
- b) Natural Resources and Productive Chains Management Program
objective: To promote environmental conservation and sustainable management of natural resources in the Rio Ouro Preto Exres.
- c) Degraded Area Recovery Program
objective: To promote the recovery of degraded areas with native species, preferably those of commercial interest.
- d) Environmental Monitoring and Protection Program
objective: To promote the protection of the Exres against invaders and curb environmental crimes.
- e) Management and Administration Program
objective: NOTHING CONTAINED!

3.4 "Common" objectives referring to the subprograms contained in the programs that make up the overall program:

Each of the five (5) programs that belong to the general program called PSAS have subprograms which were dismembered in order to better meet the specifics of ROP EXRES. The five (5) programs are divided into the following subprograms:

a) Quality of Life and Citizenship Program - divided into nine (9) sub-programs:

- a.1 Health Subprogram;
- a.2 Education Subprogram;
- a.3 Housing/living arrangements Subprogram;
- a.4 Sanitation Subprogram;
- a.5 Communication Subprogram;
- a.6 Culture Subprogram;
- a.7 Leisure and Sport Subprogram;
- a.8 Energy Subprogram;
- a.9 Transportation and Access Subprogram

b) Natural Resources and Supply Chains Management Program - divided into ten (10) subprograms:

- b.1 Rubber Subprogram;
- b.2 Brazil Nut Subprogram;
- b.3 "Other Extractive Products" Subprogram;
- b.4 Wildlife Management Subprogram;
- b.5 Fisheries Resource Subprogram s;
- b.6 Food Safety Subprogram - Agriculture;
- b.7 Food Safety Subprogram - Animal Husbandry;
- b.8 Timber Products Subprogram;
- b.9 Tourism Subprogram;
- b.10 Research Subprogram.

c) Degraded Area Recovery Program - does not have any subprograms.

d) Environmental Monitoring and Protection Program - does not have any subprograms.

e) Management and Administration program - divided into two (2) subprograms:

- e.1 Infrastructure and Personnel Subprogram;
- e.2 Land Tenure Subprogram.

Altogether there are 21 subprograms, each with its own purpose, which are detailed below:

a) Quality of Life and Citizenship Program - divided into nine (9) subprograms:

- a.1 Health Subprogram
objective: To guarantee the basic right to health care for residents of the Exres.
- a.2 Education Subprogram
objective: To ensure the right to education for residents of the Exres.
- a.3 Housing/living arrangements Subprogram
objective: To improve the quality of housing for beneficiaries of the Exres.
- a.4 Sanitation Subprogram

- objective:* To improve the quality of life of residents of the Exres through disease prevention.
- a.5 Communication Subprogram
objective: To improve communication between communities and municipal headquarters.
- a.6 Culture Subprogram
objective: To promote recovery of the culture and identity of the Exres population.
- a.7 Leisure and Sport Subprogram
objective: To encourage the practice of soccer and championships in the Exres.
- a.8 Energy Subprogram
objective: To provide electricity to all residents of the Exres.
- a.9 Transportation and Access Subprogram
objective: To ensure good access and provide regular transportation to all Exres communities.
- b) Natural Resources and Supply Chains Management Program - divided into ten (10) subprograms:
- b.1 Rubber Subprogram
objective: To add value to and improve the quality of rubber tappers' products and income.
- b.2 Brazil Nut Subprogram
objective: To add value to and improve the quality of the nut product.
- b.3 "Other Extractive Products" Subprogram
Objective: To improve the income of Exres beneficiaries through the commercialization of sustainable extractive products.
- b.4 Wildlife Management Subprogram
objective: To sustainably and adequately manage species of wildlife in the Exres that are causing damage to communities.
- b.5 Fishery Resources Subprogram
objective: To assess and enable breeding of native fish in the Exres for consumption and marketing.
- b.6 Food Safety Subprogram - Agriculture
objective: To improve agricultural practices, increasing sustainability, productivity and adding value to the products of extractive reserves.
- b.7 Food Safety Subprogram - Animal Husbandry
objective: To improve nutrition and income of beneficiaries of the Exres.
- b.8 Timber Products Subprogram
objective: To improve the income of extractivists through sustainable management of timber.
- b.9 Tourism Subprogram
objective: To involve stakeholders from Guajar Mirim in a sustainable ecotourism experience that strengthens the culture of forest peoples through the

principles of solidarity, cooperation and care for the earth.

- b.10 Research Subprogram
objective: To promote the development of research within the CU, in diverse areas of study.
- c) Degraded Area Recovery Program - does not have any subprograms.
- d) Environmental Monitoring and Protection Program - does not have any subprograms.
- e) Management and Administration program - divided into two (2) subprograms:
- e.1 Infrastructure and Personnel Subprogram
objective: To provide the Exres with adequate infrastructure and staff, as well as forming strategic partnerships to promote sound management of the CU, in order to enable the other subprograms.
- e.2 Land Tenure Subprogram
objective: To consolidate the land tenure of the Exres for full implementation of the management plan.

3.5 "Common" objectives for the "Management Agreement"

In the ROP EXRES management plan, the CU's "Plan of Use" is called the "Management Agreement". It was designed and updated in three distinct stages: a) in general assembly, with community participation through workshops on August 29 & 30, 2010; b) in 2011 it was revised and c) in 2012 it was revised, approved by ICMBio and published in the Official Journal of the Union on 02/21/13 (BRAZIL, 2014).

The ROP EXRES "Management Agreement" has only six (6) pages, consisting of nine (9) sections and 46 (forty-six) paragraphs. It has two (2) distinct objectives:

a) To ensure the self-sustainability of the EXRES by regulating the use of resources and behaviors to be followed by residents;

b) To express to ICMBio the commitment of EXRES residents to comply with environmental legislation and at the same time offer a verification tool of compliance that is accepted by all.

3.6 Strategic objectives related to the subprograms ("d" above).

Finally, the remaining objectives identified in the 2014 ROP EXRES Management Plan are so-called "strategic objectives". Similar to the "Management Agreement", it states that the stakeholders involved with the CU decided to also include "Strategic Planning" in the 2014 ROP EXRES Management Plan. Strategic objectives resulted from strategic planning.

The strategic objectives are the result of two (2) distinct segments, both of which are linked to the management plan building process, namely:

- a) they are the result of the objectives of the subprograms that make up the general program called PSAS;
- b) they are the result of the "Balanced Scorecard" method.

Construction of the strategic objectives began with community participants prioritizing the objectives of environmental and socio-economic sustainability subprograms at a workshop. [...] The most prioritized subprograms' objectives were transformed into strategic objectives. (BRAZIL, 2014, p. 137, 138)

Other strategic objectives were inserted during a discussion at the April/2013 workshop, seeking to contemplate the mission and vision of the future of the Exres. All were then arranged in the form of a map [...] using a methodology adapted from the "Balanced Scorecard" method - BSC. (BRAZIL, 2014, p. 138)

It is clear that the management plan's strategic objectives are derived from various processes and not a single activity.

Regarding these two (2) different time points, from which the strategic objectives originated during the management plan's construction process, it is important to note the following:

3.6.1 Strategic objectives as a result of the objectives of the subprograms that make up the general program called PSAS

During the "Participatory Planning Workshop" in order to generate the strategic objectives of ROP EXRES, the objectives of the 21 PSAS subprograms were presented to the entire community present. At the time, it was requested that of the 21 presented subprograms, each participant elect five (5) they considered to be of greatest importance and priority. As a result of the activity, a table was created containing the subprograms in descending order of priority according to the vote of the local community. The result was as follows:

Table 1 – Priority ranking of ROP EXRES according to election by residents in April/2013.

Order of priority	Elected themes in Descending Order of Priority	Score Obtained According to Votes Obtained
1st	Electricity	33
2nd	Rubber	25
3rd	Communication systems	24
4th	Transportation	22
5th	Sustainable forest management plan	18
6th	Payment for environmental services	17
7th	Farming practices	16
8th	Health	15
9th	Education	14
10th	Basic sanitation	13
11th	Training courses	11
12th	Brazil Nuts	09
13th	Small livestock	08
14th	Fish farming	08
15th	Other extractive products	07
16th	Tourism	07
17th	Housing	07
18th	Cultural revival	05
19th	Recovery of degraded areas	02
20th	Protection and monitoring	02
21th	Wildlife management	01
22th	Exres management	0

Preparation: Franciele Bazan.

In choosing the priorities of the CU, the community excluded four (4) items from the subprograms and added five (5) new ones in their place. Specifically:

Table 2 – Exclusion of subprograms and inclusion of new elected priority themes for ROPR EXRES during the election of the five (5) considered most relevant.

Subprograms	Excluded	New Theme Included
Quality of Life and Citizenship Program		
1 Health Subprogram	-	-
2 Education Subprogram	-	-
3 Housing/living spaces Subprogram	-	-
4 Sanitation Subprogram	-	-
5 Communication Subprogram	-	-
6 Culture Subprogram	-	-
7 Leisure and Sport Subprogram	Yes	-
8 Energy Subprogram	-	-
9 Transportation and Access Subprogram	-	-
Natural Resources and Productive Chains Management Program		
10 Rubber Subprogram	-	-
11 Brazil Nut Subprogram	-	-
12 "Other Extractive Product" Subprogram	-	-
13 Wildlife Management Subprogram	-	-
14 Fishery Resource Subprogram	-	-
15 Food Safety Subprogram - Agriculture	-	-
16 Food Safety Subprogram - Animal Husbandry	-	-
17 Timber Products Subprogram	-	-
18 Tourism Subprogram	-	-
19 Research Subprogram	Yes	-
Management and Administration Program		
20 Infrastructure and personnel Subprogram	Yes	-
21 Land Tenure Subprogram	Yes	-
	-	Payment for environmental services
	-	Training courses
	-	Recovery of degraded areas
	-	Protection and monitoring
	-	Exres management

Preparation: Luciana Fabiano.

In order to elect the five (5) most relevant priorities for the CU, the community opted to maintain 17 (seventeen) issues related to the PSAS subprograms. The following table shows the presented subprograms and the corresponding issues that remained according to the choice of the local community:

Table 3 - Subprograms presented to the community: relationship of equivalence between them and priorities for ROP EXRES as elected by residents.

Subprograms	Excluded topic	Elected themes (Equivalents)
Quality of Life and Citizenship Program		
1 Health Subprogram	-	Health
2 Education Subprogram	-	Education
3 Housing/living spaces Subprogram	-	Housing
4 Sanitation Subprogram	-	Basic sanitation
5 Communication Subprogram	-	Communication systems
6 Culture Subprogram	-	Cultural revival

7 Leisure and Sport Subprogram	Yes	
8 Energy Subprogram	-	Electricity
9 Transportation and Access Subprogram	-	Transportation
Natural Resources and Productive Chains Management Program		
10 Rubber Subprogram	-	Rubber
11 Brazil Nut Subprogram	-	Brazil Nuts
12 "Other Extractive Products" Subprogram	-	Other extractive products
13 Wildlife Management Subprogram	-	Wildlife management
14 Fishery Resources Subprogram	-	Fish farming
15 Food Safety Subprogram - Agriculture	-	Farming practices
16 Food Safety Subprogram - Animal Husbandry	-	Small livestock
17 Timber Products Subprogram	-	Sustainable forest management plan
18 Tourism Subprogram	-	Tourism
19 Research Subprogram	Yes	
Management and Administration Program		
20 Infrastructure and personnel Subprogram	Yes	
21 Land Tenure Subprogram	Yes	
		New Themes included
		1 Payment for environmental services
		2 Training courses
		3 Recovery of degraded areas
		4 Protection and monitoring
		5 Exres Management

Preparation: Luciana Fabiano.

The table below shows, in descending order, the priorities of ROP EXRES as defined by its residents:

Table 4 - Priorities of ROP EXRES in descending order as defined by its residents and the equivalent PSAS subprograms

Elected themes in Descending Order Of Priority	New Theme Included	Subprograms (equivalent)
1st Electricity	-	8 Energy Subprogram
2nd Rubber	-	10 Rubber Subprogram
3rd Communication Systems	-	5 Communication Subprogram
4th Transportation	-	9 Transportation and Access Subprogram
5th Plan for sustainable forest management	-	17 Timber Products Subprogram
6th Payment for environmental services	Yes	
7th Agricultural practices	-	15 Food Safety Subprogram - Agriculture
8th Health	-	1 Health Subprogram
9th Education	-	2 Education Subprogram
10th Sanitation	-	4 Sanitation Subprogram
11th Training Courses	Yes	
12th Brazil Nuts	-	11 Brazil Nut Subprogram
13th Breeding of small livestock	-	16 Food Safety Subprogram - Animal Husbandry
14th Fish farming	-	14 Fishery Resources Subprogram
15th Other extractive products	-	12 "Other Extractive Products" Subprogram
16th Tourism	-	18 Tourism Subprogram
17th Housing	-	3 Housing/living spaces Subprogram
18th Cultural Revival	-	6 Culture Subprogram

19th Restoration of degraded areas	Yes	
20th Protection and monitoring	Yes	
21st Wildlife management	-	13 Wildlife Management Subprogram
22nd Exres management	Yes	

Preparation: Luciana Fabiano.

3.6.2 Strategic objectives as a result of the "Balanced Scorecard" method

Strategic objectives are derived using the "Balanced Scorecard" method (BSC). BSC produces performance indicators based on five (5) references, namely: a) environment/society; b) beneficiaries; c) internal processes; d) learning and e) resources.

The ROP EXRES Management Plan (2014) indicates that the strategic objectives produced from the BSC method were arranged on a map, keeping in mind that the validity of these amounts to five (5) years starting from

2014. The Management Plan records the fact that both the map and the strategic objectives can undergo changes and updates without the need to do the same with the Management Plan. The map and the modified strategic objectives can even remain part of the Management Plan.

In order to obtain the strategic objectives, five (5) BSC benchmarks with fundamental questions based on Cabral (2012) came together at the April/2013 workshop. The questions, in turn, were associated with keywords:

Table 5 - BSC methodology adapted and applied to the "Participatory Planning Workshop" in April / 2013 for the strategic objectives of ROP EXRES

Referential BSC Method	Questions - Cabral (2012)	Keywords
Environment /Society	To fulfill the mission and achieve the vision of the future, what results should be achieved in relation to the conservation of the environment and society? How should we care for the environment and society?	IMPACT
Beneficiaries	To achieve the vision of the future and care for the environment and society, how should we care for users?	RESULT IN/PRODUCE
Internal processes	To relate to our users and care for the environment and society, which internal processes do we need to be good?	DO
Learning	To be good in the processes considered critical for strategy, what training and learning should our team seek out? What technologies do we need to access? How and in which fields do we need to innovate?	BE
Resources	What are the financial and human challenges to fulfill the identified objectives and to achieve the vision of the future? How can we access and take care of the resources necessary to enable CU strategy?	HAVE

Source: Adapted from the 2014 ROP EXRES Management plan, p. 139.

In the end, adaptation of the BSC method to Cabral's questions (2012) originated in all twenty (20) strategic objectives achieved with community participation, presented in the table below:

Table 6 - Strategic objectives achieved through the BSC method - Balanced ScoreCard

Keyword	Strategic objectives
Impact	1 To be recognized for their environmental services
	2 Constitute a barrier to deforestation in Rondônia
	3 Allow for the continuity of man in the forest
Produce	4 To enable access to electricity
	5 Improve beneficiary income
	6 Improve communication between communities and the city
	7 Ensure access to education

	8 Ensure access to health care
	9 Ensure adequate transportation
Do	10 To settle the land situation
	11 Facilitate the PMFS
	12 Lobby with the government and other organizations
	13 Promote improvement of the rubber and Brazil nut productive chains
	14 Establish partnerships to improve agricultural practices
	15 Implement a community-based tourism plan
Be	16 To develop the technical and managerial competence of the staff with a focus on conflict management, GIS, land tenure, traditional populations, protected area management, and public policies for the target population.
	17 Promote training for beneficiaries in the following areas: administrative organization, forest management, farming techniques, Brazil nuts and rubber.
Have	18 To expand the number of collaborators and employees
	19 Access financial resources from the central administration and capture alternative sources (ICMBio)
	20 Obtain administrative and financial self-sustainability (associations)

Source: Adapted from the 2014 ROP EXRES Management plan, p. 140.

Upon comparison of the strategic objectives obtained from the BSC method with the strategic objectives coming from the subprograms of the larger PSAS program, one can observe new exclusions of previous goals as well as new additions of other objectives that had not been previously mentioned.

The following table shows the exclusions, inclusions and equivalencies between their strategic goals: those from the subprograms of the PSAS program and those from the BSC method:

Table 7 - Final result of the strategic objectives - PSAS and BSC subprograms

Subprograms	BSC Goals - Equivalent to - Strategic Objectives	
Quality of Life and Citizenship Program		
1 Health Subprogram	Ensure access to health care	1
2 Education Subprogram	Ensure access to education	2
3 Housing/living spaces Subprogram # Excluded in the application of the BSC method	-	
4 Sanitation Subprogram # Excluded in the application of the BSC method	-	
5 Communication Subprogram	Improve communication between communities and the city	3
6 Culture Subprogram # Excluded in the application of the BSC method	-	
7 Leisure and Sport Subprogram * Excluded in the election of five priorities # Excluded in the application of the BSC method	-	
8 Energy Subprogram	Provide access to electricity	4
9 Transportation and Access Subprogram	Ensure adequate transportation	5
Natural Resources and Productive Chains Management Program		
10 Rubber Subprogram	Promote improvements in the rubber production chain	6
11 Brazil Nut Subprogram	Promote improvements in the Brazil nut production chain	7

12 " Other Extractive Products" Subprogram	Improve beneficiary income	8
13 Wildlife Management Subprogram # Excluded in the application of the BSC method	-	
14 Fishery Resources Subprogram # Excluded in the application of the BSC method	-	
15 Food Safety Subprogram - Agriculture	Establish partnerships for the improvement of agricultural practices	9
16 Food Safety Subprogram - Animal Husbandry # Excluded in the application of the BSC method	-	
17 Timber Products Subprogram # Excluded in the application of the BSC method	-	
18 Tourism Subprogram	Implement a community-based tourism plan	10
19 Research Subprogram * Excluded in the election of five priorities # Excluded in the application of the BSC method	-	
Management and Administration Program		
20 Infrastructure and personnel Subprogram * Excluded in the election of five priorities	- Develop the technical and managerial competence of staff, focusing on ... - Expand the number of collaborators and employees.	11
21 Land Tenure Subprogram * Excluded in the election of five priorities	Regulate the land situation	12
New Themes Included as Priorities From the Subprograms		
Payment for environmental services	Be recognized for their environmental services	13
Training courses	Promote training for beneficiaries in the areas...	14
Recovery of Degraded Areas	Enable the PMFS ¹	15
Protection and monitoring	Become a barrier to deforestation	16
Exres management	Obtain administrative and financial self-sustainability (associations)	17
New Objectives Included from the BSC Method		
	Ensure the continuity of man in the forest	18
	Lobby with the government and other organizations	19
	Access financial resources from the central administration and from alternative sources (ICMBio)	20

Preparation: Luciana Fabiano.

¹ Plan for Sustainable Forest Management.

This chapter introduced the types of objectives found in the 2014 ROP EXRES Management plan. Data analysis will be presented below. The next chapter deals with the analysis of the objectives found in the 2014 ROP EXRES Management plan according to the problem that guided the theoretical framework of this study: What does the ROP EXRES "Management Plan - 2014" indicate regarding the objectives of this CU, according to the 8 indicators of "Module 6 - Objectives" from the RAPPAM method?

In order to present the analysis of the objectives found, the procedure adopted consists of: whether every question in - Module 6 - "Objectives" of the RAPPAM method (there are six (6) questions in all), shows the presence or absence of an indicator (related to the question) in each of the six (6) types of objectives in the management plan, followed by characterization of each objective.

IV. ANALYSIS OF QUESTIONS FROM "MODULE 6 - OBJECTIVES" OF THE RAAPAM METHOD

In order for protected areas to achieve the main objective for which they were created, it is necessary to have a clear understanding of all the objectives that underlie the process in which they operate. The quality of the environment and nature contained within them are not an asset meant to benefit each PA alone; rather, their benefits extend to all areas, to all people. Just to illustrate a few examples:

In a social sense, PAs are important because it is a way to attract the attention of national and international institutions that are involved with preservation, inducing people all over the world, not only the residents of the Exres, to more fully participate in decisions involving PAs across the planet. In this sense the internal and external community to CUs, feel like they are participating in the process and this allows the entire involved community greater assimilation of values of preservation and protection of nature.

In an environmental sense, profound knowledge of the objectives of a CU can be used as an administrative tool to contribute to the technical work of professionals who can improve and enhance the management of an extractive reserve and any other area of preservation and conservation. The whole of society and those involved directly realize how administrators who are knowledgeable of the objectives directly influence environmental preservation.

In the field of health, prior and clear knowledge of a CU's objectives promotes the welfare of society as a whole, since living in a balanced and pollution-free environment is a right that engages and draws the world's attention since everything is connected and our actions against the Amazon can directly affect neighboring countries.

In the field of education, it is possible through the data obtained herein, to establish plan of action to assist educators to include relevant environmental activities which can influence and train future efficient managers.

In the field of politics, it strengthens associations and leaders of other reserves around the world, as a way to achieve greater benefits or incentives, since community leaders involved with local politics have greater knowledge of the features, characteristics and needs of a CU.

In the field of economics, it is essential that associations linked directly to Exres and PAs generally have profound knowledge of their objectives, in such a way that they can make a structured base and prevail in domestic and foreign markets through the marketing of its natural products, where permitted by law.

For the above reasons, a thorough analysis of the objectives found in the 2014 ROP EXRES management plan was carried out.

4.1 QUESTION "A" FROM "MODULE 6 - OBJECTIVES" OF THE RAPPAM METHOD: DO THE CU'S OBJECTIVES INCLUDE PROTECTION AND CONSERVATION OF BIODIVERSITY?

The indicators that are present in question "A" of "Module 6 - Objectives" of the RAPPAM method are: "protection and "conservation". The criteria used to identify the presence of these indicators in the objectives of the 2014 ROP EXRES Management Plan was the concept adopted by Costa (2007) for the term "conservation". According to the author the concept of "conservation" is associated with understanding the sustainable use of natural resources. Hence it follows, that "protect" can be defined as the integral maintenance of natural resources, of which is not foreseen any kind of use, even in a sustainable manner. The indicators presented are included in the following types of objectives of the 2014 ROP EXRES management plan:

Table 8 - Indicators "protection" and "conservation" present in the "six (6) TYPES OF OBJECTIVES" in the 2014 ROP EXRES management plan.

TYPES OF OBJECTIVES that currently exist in the management plan	Present Indicators: 1) PROTECTION and 2) CONSERVATION
a) Type 1 - Specific objectives related to the CU ROP EXRES;	1) PROTECTION 2) CONSERVATION
b) Type 2 - General objective concerning the general program "Environmental and Socioeconomic Sustainability Programs" (PSAS) of the Unit;	2) CONSERVATION
c) Type 3 - "Common" objectives referring to the programs contained in the aforementioned general program;	1) PROTECTION 2) CONSERVATION
d) Type 4 - "Common" objectives referring to the subprograms contained in the programs that make up the PSAS;	1) PROTECTION 2) CONSERVATION
e) Type 5 - "Common" objectives for the "Management Agreement";	1) PROTECTION 2) CONSERVATION
f) Type 6 - Strategic objectives related to the subprograms ("d" above).	1) PROTECTION 2) CONSERVATION

Preparation: Luciana Fabiano

Table 9 – The indicators "protection" and "conservation" present in "TYPE 1 - SPECIFIC OBJECTIVES" of the 2014 ROP EXRES management plan.

TYPE 1 - SPECIFIC OBJECTIVES from the Management Plan	Present Indicators: 1) PROTECTION and 2) CONSERVATION
a) Ensure a free work area for the extractivists with not bosses	-
b) Avoid invasions in the Exres area	1) PROTECTION
c) Preserve the native forest	1) PROTECTION 2) CONSERVATION
d) Ensure the sustainable use of natural resources	1) PROTECTION 2) CONSERVATION
e) Promote access to education and health care for beneficiaries	-

Preparation: Luciana Fabiano

Table 10 - Indicators "protection" and "conservation" present in "TYPE 2 - GENERAL OBJECTIVE OF PSAS" of the 2014 ROP EXRES management plan.

TYPE 2 - GENERAL OBJECTIVE OF PSAS in the management plan	Present Indicators: 1) PROTECTION and 2) CONSERVATION
Promote environmental conservation, sustainable management of natural resources, value culture and improve the quality of life of traditional populations	2) CONSERVATION

Preparation: Luciana Fabiano

Table 11 - Indicators "protection" and "conservation" present in "TYPE 3 - OBJECTIVES OF 5 PSAS PROGRAMS" of the 2014 ROP EXRES management plan.

TYPE 3 - OBJECTIVES OF 5 PSAS PROGRAMS in the management plan	Present Indicators: 1) PROTECTION and 2) CONSERVATION
a) Quality of Life and Citizenship Program <i>objective:</i> To value culture and improve the quality of life of the traditional Exres	-

population.	
b) Natural Resources and Productive Chains Management Program <i>objective:</i> To promote environmental conservation and sustainable management of natural resources in the Rio Ouro Preto Exres.	2) CONSERVATION
c) Degraded Area Recovery Program <i>objective:</i> To promote the recovery of degraded areas with native species, preferably those of commercial interest.	2) CONSERVATION
d) Monitoring and Environmental Protection Program <i>objective:</i> To promote protection of the Exres against invaders and curb environmental crimes.	1) PROTECTION
e) Management and Administration Program <i>objective:</i> NOTHING CONTAINED!	-

Preparation: Luciana Fabiano

Table 12 - Indicators "protection" and "conservation" present in "TYPE 4 - OBJECTIVES OF THE SUBPROGRAMS" from the 2014 ROP EXRES management plan.

Subprograms	TYPE 4 - OBJECTIVES OF THE SUBPROGRAMS	Present Indicators: 1) PROTECTION and 2) CONSERVATION
a) Quality of Life and Citizenship Program - divided into nine (9) subprograms:		
a.1 Health Subprogram	Ensure the basic right to health care for residents of the Exres.	-
a.2 Education Subprogram	Ensure the right to education for residents of the Exres.	-
a.3 Housing/living space Subprogram	Improve the quality of housing of the beneficiaries of the Exres.	-
a.4 Sanitation Subprogram	Improve the quality of life of residents of the Exres through disease prevention.	-
a.5 Communication Subprogram	Improve communication between communities and municipal headquarters.	-
a.6 Culture Subprogram	Promote recovery of the culture and identity of the Exres population.	-
a.7 Leisure and Sport Subprogram	Encourage the practice of soccer and championships in the Exres.	-
a.8 Energy Subprogram	Provide electricity to all residents of the Exres.	-
a.9 Transportation and Access Subprogram	Ensure good access to and provide regular transportation to all Exres communities	-
b) Natural Resources and Supply Chains Management Program - divided into ten (10) subprograms:		
b.1 Rubber Subprogram	Add value to and improve the quality of the rubber tapper's product and income	-
b.2 Brazil Nut Subprogram	Add value to and improve the quality of the product Brazil nuts.	-
b.3 "Other Extractive Products" Subprogram	Improve the income of the Exres beneficiaries through the commercialization of sustainable extractive products.	-
b.4 Wildlife Management Subprogram	Sustainably and adequately manage species of wildlife in the Exres that are causing damage to communities.	1) PROTECTION 2) CONSERVATION
b.5 Fishery Resources Subprogram	Evaluate and facilitate the breeding of native fish in the Exres for consumption and marketing.	

b.6 Food Safety Subprogram - Agriculture	Improve agricultural practices, increasing sustainability, productivity and adding value to the products of extractive reserves.	1) PROTECTION 2) CONSERVATION
b.7 Food Safety Subprogram - Animal Husbandry	Improve nutrition and income of the beneficiaries of the Exres.	
b.8 Timber Products Subprogram	Improve the income of extractivists through the sustainable management of timber.	1) PROTECTION 2) CONSERVATION
b.9 Tourism Subprogram	Involve stakeholders from Guajará Mirim in a sustainable ecotourism experience that strengthens the culture of forest peoples through the principles of solidarity, cooperation and care for the earth.	1) PROTECTION 2) CONSERVATION
b.10 Research Subprogram	Promote the development of research within the CU, in various areas of study.	
c) Degraded Area Recovery Program		
It does not have any subprograms.		
d) Monitoring and Environmental Protection Program		
It does not have any subprograms.		
e) Management and Administration Program - divided into two (2) subprograms:		
e.1 Infrastructure and Personnel Subprogram	Provide the Exres with adequate infrastructure and staff, as well as forming strategic partnerships to promote sound management of the CU, in order to enable the other subprograms.	
E.2 Land Tenure Subprogram	Consolidate land tenure of the Exres for full implementation of the management plan.	

Preparation: Luciana Fabiano

Table 13 - Indicators "protection" and "conservation" present in "TYPE 5 - MANAGEMENT AGREEMENT OBJECTIVES" from the 2014 ROP EXRES management plan.

TYPE 5 - MANAGEMENT AGREEMENT OBJECTIVES in the management plan	Present Indicators: 1) PROTECTION and 2) CONSERVATION
a) To ensure self-sustainability of the EXRES by regulating the use of resources and behaviors to be followed by residents;	2) CONSERVATION
b) To express to ICMBio the commitment of EXRES residents to comply with environmental legislation and at the same time offer a verification tool of compliance to norms that is accepted by all.	-

Preparation: Luciana Fabiano

Table 14 - Indicators "protection" and "conservation" present in "TYPE 6 - STRATEGIC OBJECTIVES OF THE BSC METHOD" from the 2014 ROP EXRES management plan.

Keyword	TYPE 6 - STRATEGIC OBJECTIVES FROM THE BSC METHOD	Present Indicators: 1) PROTECTION and 2) CONSERVATION
Impact	1 To be recognized for their environmental services	2) CONSERVATION
	2 Constitute a barrier to deforestation in Rondônia	1) PROTECTION
	3 Allow for the continuity of man in the forest	-
Result in	4 Enable access to electricity	-
	5 Improve the income of Beneficiaries	-

	6 Improve communication between communities and the city	-
	7 Ensure access to education	-
	8 Ensure access to health care	-
	9 Ensure adequate transportation	-
Do	10 Settle the Land situation	1) PROTECTION
	11 Facilitate the PMFS	1) PROTECTION 2) CONSERVATION
	12 Lobby with the government and other organizations	-
	13 Promote improvement of the rubber and Brazil nut productive chains	-
	14 Establish partnerships to improve agricultural practices	2) CONSERVATION
	15 Implement a community-based tourism plan	-
Be	16 To develop the technical and managerial competence of the staff with a focus on conflict management, GIS, land tenure, traditional populations, protected area management, and public policies for the target population.	1) PROTECTION
	17 Promote training for beneficiaries in the following areas: administrative organization, forest management, farming techniques, Brazil nuts and rubber.	1) PROTECTION 2) CONSERVATION
Have	18 Expand the number of collaborators and employees	-
	19 Access financial resources from the central administration and capture alternative sources (ICMBio)	-
	20 Obtain administrative and financial self-sustainability (associations)	-

Preparation: Luciana Fabiano

Before starting the discussion on what answers were found in the management plan, it is important to know the meaning of each term (indicator) present in the first question of the RAPPAM method: "Do the PA's objectives include the **protection** and **conservation** of biodiversity?"

To ensure the maintenance of an ecologically balanced ecosystem, **protection** and **conservation** measures aimed at biodiversity should be adopted so that the services that result from environmental interactions that are essential to humans' well-being will be protected.

The term **protection** is associated with the set of measures taken to minimize the risk of contamination to and deterioration of the environment. According to SNUC (2000) only indirect use of forest resources is permitted, avoiding any modification or interference by human beings that could cause irreversible damage or destruction.

Conservation, on the other hand, is classified as *ex situ* when looking to conserve certain species outside their habitat or *in situ* when seeking to preserve and maintain various species in their natural habitats. Conservation can be defined as the set of standards geared to human well-being, through conscious and rational use of environmental resources in a particular area.

When defining an explored area it is easier to identify the weakest points within a unit, those susceptible to deforestation and environmental degradation; in this sense, environmental conservation is configured as a tool used to contain or at least minimize negative environmental impacts. It includes protecting and maintaining the renewal of forest areas and the survival of its species for present and future generations.

In summary, one can say that for environmental sciences, conservation is related to the use and management of areas in a sustainable way (COSTA, 2007, p. 3).

Overall, while the term "protection" is related to the integrity of nature in its entirety, conservation is linked to man's ability to manage natural resources in a conscious way. But together they are the means which man uses in order to create and develop instruments to contain major environmental problems. For example:

- a) Loss and alteration of habitats and biodiversity;
- b) Predatory exploitation of resources;
- c) Introduction of foreign species into ecosystems;
- d) Increase of pathogens;
- e) Increase of environmental toxicants; and
- f) Climate change (ALHO, 2012, p. 153).

A management plan should take into consideration, in its studies, the diversity of environments and ecosystems, protection of the CU along with its conservation, environmental impacts and other socio-environmental aspects, according to instructions set forth by IN-ICMBIO 01/2007. It has already been mentioned herein that the ROP EXRES management plan was prepared according to IN-ICMBIO 01/2007; IBAMA's Methodological Roadmap for the Development of Sustainable Federal Extractive Reserve Management Plans, published in 2006, was also used in its elaboration.

We will now look at the features found regarding the indicators "protection" and "conservation" within six (6) types of objectives present in the ROP EXRES management plan:

TYPE 1 - SPECIFIC OBJECTIVES

Even before the ROP EXRES Management plan was prepared, concern for the "protection" and "conservation" of the CU under study proved to be a concern for its community, since the above indicators are contained in the first objectives written for the Exres.

It turns out that the so-called "Specific Objectives" are the first on record to have been developed during the creation of the CU ROP EXRES. Although they are not included in any document on a date prior to the preparation of the management plan, the community contributed to the remembrance of their existence in a "Participatory Workshop" held in April/2013 as recorded in the management plan itself:

The decree creating the Rio Ouro Preto Exres does not describe the specific objectives of the unit. Therefore, during the participatory workshop in April 2013, a discussion began, especially amongst the older leaders, seeking to highlight the importance of the Exres and remember the reasons that subsidized its creation and its objectives. (BRAZIL, 2014, p. 137)

Among the five (5) "Specific Objectives", 3 (three) of them include the indicators "protection" and "conservation", namely:

Table 15 - Indicators "protection" and "conservation" present in "TYPE 1 - SPECIFIC OBJECTIVES" of the 2014 ROP EXRES management plan.

TYPE 1 - SPECIFIC OBJECTIVES of the Management Plan	Present Indicators: 1) PROTECTION and 2) CONSERVATION
a) Ensure free work area for extractivists with no bosses	-
b) Avoid invasions in the	1) PROTECTION

Exres area	
c) Preserve the native forest	1) PROTECTION 2) CONSERVATION
d) Ensure the sustainable use of natural resources	1) PROTECTION 2) CONSERVATION
e) Promote access to education and health care for beneficiaries	-

Preparation: Luciana Fabiano.

From the point of view of the reality of the ROP EXRES community as well as considering the context in which the CU in study is inserted, it's easy to see the importance of including the indicators "protection" and "conservation" in each of the objectives:

TYPE 1 b) Avoid invasions in the Exres area - PROTECTION

In ROP EXRES, invasions have been detected at several points, especially by hunters and prospectors. Invasions are harmful to the "health" of the forest, because it is one of the reasons for the increase in deforestation and extinction of some species of flora and fauna.

The Amazon rainforest has been the target of frequent attacks without any solid and real action to put an end to these frequent inhumane actions. These actions include uncontrollable, ambitious and aggressive behaviors that ultimately lead to invading armies usurping natural resources. In fact, men themselves act as predators by ravaging huge natural areas which, desolate of any resilience, become deserts where nature is harmed. (BUARQUE, 2013, p. 1).

Avoiding invasions means protecting forest resources and ensuring the livelihood of communities, reducing the pressure on some animals and plants consumed by residents.

TYPE 1 c) Preserve the native forest - PROTECTION AND CONSERVATION

Native or natural forest vegetation corresponds to those that originate within the protected area, and has not undergone any change caused by human interference. ROP EXRES consists of various types of vegetation, housing a large biological diversity. Thus, it's important to protect it and conserve its resources.

The country has the largest area of primary rainforest in the world, one-fifth of the fresh water contained in this forest, and around a third of the planet's biodiversity. (BRASÍLIA, 2017, p. 8)

According to Guimarães (2018), preserving the native forest is important because when an area is cleared, the vegetation that make up that ecosystem changes dramatically, not only affecting the flora and fauna in the area, but also affecting 85% (eighty-five) of life around the deforested area; this is the so-called border effect.

With the preservation of at least 40% of the original vegetation, the forest is rich in large trees with fruits whose seeds are dispersed by birds and mammals such as tapirs, toucans and agoutis. In the shaded area, amphibians and reptiles avoid excessive heat (GUIMARÃES, 2018, p. 4).

TYPE 1 d) Ensure the sustainable use of natural resources - PROTECTION AND CONSERVATION

To ensure or guarantee is no easy task, but there are many modalities and instruments with which one can achieve the objective proposed herein. Examples of these tools include sound legal frameworks, laws, decrees, resolutions, and legislation in general. Another way for this to be achieved is to empower people in the practice of sustainability; this term, although widely publicized, in practice the majority of the population, when asked to

Table 16 - Indicators "protection" and "conservation" Present In "TYPE 2 - GENERAL OBJECTIVE OF PSAS" in the 2014 ROP EXRES Management Plan.

TYPE 2 - GENERAL OBJECTIVE OF THE PSAS in the management plan	Present Indicators: 1) PROTECTION and 2) CONSERVATION
Promote environmental conservation, sustainable management of natural resources, value culture and improve the quality of life of traditional populations	2) CONSERVATION

Preparation: Luciana Fabiano.

The verb "promote" indicates the need to introduce more "conservation" practices in the environment as a whole, some of which are still not included in the daily life of the community, arising from the evolution of the concept of sustainability linked to the discovery of the finiteness of natural resources, rather than the idea of infinite resources. It also indicates promoting conservation in the sense of a continuous, i.e. constant, process.

Table 17 - Programs and subprograms of ROPEXRES based on IBAMA's records

PROGRAMS	SUBPROGRAMS
Quality of Life and Citizenship Program	Health, Education, Housing/living arrangements, sanitation, communication, Culture, Leisure and Sport, Energy, Transportation and Access
Natural Resources and Productive Chains Management Program	Rubber, Brazil nuts, "Other Extractive products," Wildlife Management, Fisheries Resources, Food Security (Agriculture and

describe its meaning, is ignorant on the subject. This objective can be obtained through surveillance, registration and controlling technological tools, such as drones, accurate georeferencing devices, software calculations and projections about possible natural disasters or those caused by human interference, etc. Either way, the important thing is that the specific objectives of the CU ensure this as a primary premise.

Ensuring sustainable use implies "protection" and implies "conservation" by those who "make use", that is, the CU's own internal community and society outside the CU. Sustainable use enables protection of natural resources and also makes it possible to conserve these resources.

TYPE 2 - GENERAL PSAS OBJECTIVE

In turn, in summarizing the main objective of the PSAS, is to encompass the objectives of each of its 21 subprograms, combining the indicator "conservation" with the word "sustainable" to form the ideal partnership between the idea of maintaining the quality of nature as well as maintaining the quality of life of man himself.

TYPE 3 - OBJECTIVES OF THE 5 PSAS PROGRAMS

IBAMA's development plan sets out a number of programs and subprograms meant to promote social, economic and environmental development of the extractive reserve; it is at the discretion of each reserve to add, delete, or unite them according to their needs. Based on this, ROP EXRES defined each program and subprogram as shown below:

	Animal Husbandry), Timber Products, Tourism and Research
Degraded Areas Recovery Program	Nothing contained
Environmental Monitoring and Protection Program	Nothing contained
Management and Administration Program	Infrastructure and personnel, Land Tenure

Source: Adapted from the 2014 ROP EXRES management plan.

Of the five (5) "Program Objectives" that make up this type of ROP EXRES objective, three (3) include the indicators "protection" and "conservation":

Table 18 - Indicators "protection" and "conservation" present in "TYPE 3 - OBJECTIVES OF THE 5 PSAS PROGRAMS" of the 2014 ROP EXRES management plan.

TYPE 3 - OBJECTIVES OF THE 5 PSAS PROGRAMS in the management plan	Present Indicators: 1) PROTECTION and 2) CONSERVATION
a) Quality of Life and Citizenship Program <i>objective:</i> To value culture and improve the quality of life of traditional Exres populations.	-
b) Natural Resources and Productive Chains Management Program <i>objective:</i> To promote environmental conservation and sustainable management of natural resources in the Rio Ouro Preto Exres.	2) CONSERVATION
c) Degraded Area Recovery Program <i>objective:</i> To promote the recovery of degraded areas with native species, preferably those of commercial interest.	2) CONSERVATION
d) Environmental Monitoring and Protection Program <i>objective:</i> To promote protection of the Exres against invaders and curb environmental crimes.	1) PROTECTION
e) Management and Administration Program <i>objective:</i> NOTHING CONTAINED!	-

Preparation: Luciana Fabiano.

Regarding these objectives relating to the PSAS Programs:

TYPE 3 b) Promote environmental conservation and sustainable management of natural resources in the Rio Ouro Preto Exres- CONSERVATION

This goal is an abbreviation; it appears that it is inserted in the General Objective of PSAS "*Promote environmental conservation, sustainable management of natural resources, value culture and improve the quality of life of the traditional population.*" Here the difference is the indication that in this case conservation and sustainability are specific to ROP.

TYPE 3 c) Promote the recovery of degraded areas with native species from the region, preferably those of commercial interest - CONSERVATION

The 2014 ROP EXRES Management plan contains a list of native fauna and flora. Associating natural species of the reserve with those of globally recognized interest is a strategy in order to ensure the survival of the resident community. The following two passages demonstrate a concern with this situation:

The main extractive products with marketing purposes used in the EXRES are rubber and Brazil nuts (ICMBio, 2008d, ICMBio, 2008f). In field research in May 2009, other native flora products were recorded as having been extracted for local use, in insignificant amount by some locals, but these are important indications of potential extractive activities of the unit. (BRAZIL, 2014, p. 65)

Reduced earnings from the practice of extraction of rubber and Brazil nuts currently make residents intensify agricultural activities and the breeding of small livestock, in order to obtain a better income. The medium- and long-term expansion of these activities on afforested areas can set a threat to the conservation of natural resources of the EXRES, as previously mentioned. On the other hand, this threat can be tackled by creating alternatives for sustainable income, valuable extractive products and by improving basic services and infrastructure (education, energy, health, transportation, sanitation and communication). (BRAZIL, 2014, p. 101)

TYPE 3 d) Promote protection of the Exres against invaders and curb environmental crimes - PROTECTION

Several parts of the management plan address the constant, imminent threat of environmental crimes, requiring daily protection of the CU:

Regarding illegal logging and hunting of wild animals practiced by outsiders, according to testimony from residents. (BRAZIL, 2014, p. 97)

Attention points: illegal fishing invaded areas between the Nossa Senhora dos Seringueiros community and the mouth of the river, the area near the southern border, east side; and also the occurrence of many hunts by indigenous neighbors (Pacaas Novos Indigenous Lands); in the Pompey region down along the right edge of the bedrock, there are still problems including invasions, deforestation, and cattle raising by non-traditional occupants. (BRAZIL, 2014, p. 99)

The entry region for poachers and timber theft is by the tributaries; it is an area of threat for dismemberment and new invasions (exclusion proposal area). (BRAZIL, 2014, p. 99)

The final departure of traditional populations from the area could leave it even more vulnerable to raids and predatory and irregular use of natural resources. (BRAZIL, 2014, p. 100)

TYPE 4 - OBJECTIVES OF THE SUBPROGRAMS

Each subprogram has a specific objective. During preparation of the management plan, a workshop for the community was held in order to choose the most important objectives to be achieved in a period of five (5) years. The result of the workshop is presented in Table 2:

Table 2 – Subprogram themes ranked in descending order of priority.

THEMES OF THE SUBPROGRAMS	POINTS
1st Electricity	33
2nd Rubber	25
3rd Communication Systems	24
4th Transportation	22
5th Plan for Sustainable Forest Management (PMFS)	18
6th Payment for Environmental Services	17
7th Agricultural Practices	16
8th Health	15
9th Education	14
10th Basic Sanitation	13
11th Training Courses	11
12th Brazil Nuts	9
13th Breeding of Small Livestock	8
14th Fish farming	8
15th Other Extractive Products	7
16th Tourism	7

17th Housing	7
18th Cultural Revival	5
19th Degraded Areas Recovery	2
20th Protection and Monitoring	2
21st Wildlife Management	1
22nd Exres Management	0
Total	264

Source: 2014 ROP EXRES Management plan, p. 138.

Table 2 shows the subprograms with points according to the order of preference of the residents; the item considered most relevant was electricity with 33 points. Not surprisingly the 2nd (second) highest scoring subprogram was that referring to rubber, since many of the residents are remnants of the economic rubber boom.

The "Plan for Sustainable Forest Management" appears in 5th (fifth) place in the table; however, the fact that subprograms like Degraded Area Recovery, Protection and Control, Wildlife Management, and EXRES Management appear in the four (4) last positions (only accounting for 5 (five) points), shows the depreciation of environmental protection by extractivists.

After defining the objectives of the subprograms of greatest need, which were later turned into strategic objectives, it was necessary to define the ways in which to achieve them. Therefore, the team responsible for developing the management plan based its work on the strategic planning method, a technique used to organize various ideas of a group to define the best way to move forward in order to achieve a certain goal (JEROZOLIMSK, 2013).

Thus, planning is thinking before acting. To manage a protected area, it is necessary to evaluate the different possibilities of action and decide which are the best alternatives. Planning allows for better use of time and resources. The objectives of a conservation unit can be achieved more easily when planned methodically (JEROZOLIMSK, 2013, p.14).

Managers need, even with limited resources, to learn how to develop efficient alternatives for the development of the unit, but before making any decision they need to reflect on what results need to be achieved, i.e., think, then act.

According to the chart below, it is evident that the indicators "protection" and "conservation" are only part of the group of subprogram objectives belonging to the program entitled "b) Natural Resources and Productive Chains Management Program - divided into ten (10) subprograms. Even then, of the ten (10) subprograms, only 4 (four) of them include the indicators being herein studied, "protection" and "conservation":

Table 19 - Indicators "protection" and "conservation" present in "TYPE 4 - OBJECTIVES OF THE SUBPROGRAMS" in the 2014 ROP EXRES management plan.

Subprograms	TYPE 4 - OBJECTIVES OF THE SUBPROGRAMS	Present Indicators: 1) PROTECTION and 2) CONSERVATION
a) Quality of Life and Citizenship Program - divided into nine (9) subprograms:		
a.1 Health Subprogram	Ensure the basic right to health care for residents of the Exres.	-
a.2 Education Subprogram	Ensure the right to education for residents of the Exres.	-
a.3 Housing/living arrangements Subprogram	Improve the quality of housing for beneficiaries of the Exres.	-
a.4 Sanitation Subprogram	Improve the quality of life for residents of the Exres through disease prevention.	-
a.5 Communication Subprogram	Improve communication between communities and municipal headquarters.	-
a.6 Culture Subprogram	Promote revival of the culture and identity of the Exres population.	-
a.7 Leisure and Sport Subprogram	Encourage the practice of soccer and championships in the Exres.	-
a.8 Energy Subprogram	Provide electricity to all residents of the Exres.	-
a.9 Transportation and Access Subprogram	Ensure good access to and provide regular transportation to all Exres communities	-
b) Natural Resources and Supply Chains Management Program - divided into ten (10) subprograms:		
b.1 Rubber Subprogram	Add value to and improve the quality of rubber tapping products.	-
b.2 Brazil Nut Subprogram	Add value to and improve the quality of the product Brazil nuts.	-
b.3 "Other Extractive Products" Subprogram	Improve the income of Exres beneficiaries through the commercialization of sustainable extractive products.	-
b.4 Wildlife Management Subprogram	Sustainably and adequately manage species of wildlife in the Exres that are causing damage to communities.	1) PROTECTION 2) CONSERVATION
b.5 Fishery Resources Subprogram	Assess and facilitate the breeding of native fish in the Exres for consumption and marketing.	
b.6 Food Safety Subprogram - Agriculture	Improve agricultural practices, increasing sustainability, productivity and adding value to the products of extractive reserves.	1) PROTECTION 2) CONSERVATION
b.7 Food Safety Subprogram - Animal Husbandry	Improve nutrition and income of beneficiaries of the Exres.	
b.8 Timber Products Subprogram	Improve the income of extractivists through sustainable management of timber.	1) PROTECTION 2) CONSERVATION
b.9 Tourism Subprogram	Involve stakeholders from Guajar Mirim in a sustainable ecotourism experience that strengthens the culture of forest peoples through the principles of solidarity, cooperation and care for the earth.	1) PROTECTION 2) CONSERVATION
b.10 Research Subprogram	Promote the development of research within the CU, in various areas of study.	
c) Degraded Area Recovery Program		
It does not have any subprograms.		

d) Environmental Monitoring and Protection Program		
It does not have any subprograms.		
e) Management and Administration program - divided into two (2) subprograms:		
e.1 Infrastructure and Personnel Subprogram	Provide the Exres with adequate infrastructure and staff, as well as forming strategic partnerships to promote sound management of the CU, in order to enable the other subprograms.	
E.2 Land Tenure Subprogram	Consolidate land tenure of the Exres for full implementation of the management plan.	

Preparation: Luciana Fabiano.

TYPE 4 b.4) Sustainably and adequately managing Exres wildlife species that are causing damage to communities - PROTECTION AND CONSERVATION

Wild animals are animals that live in nature in different types of ecosystems that have not been domesticated by man. They do not have much contact with humans, so when they come into contact with man they become aggressive; they are called non-domesticated. ROP EXRES is rich in wildlife as recorded in its management plan:

The fauna of the Exres is typical of the Amazon biome, including a wide variety of wild animals. In the lowlands acai and bacaba is found, whose fruits attract macaws, inhambus, trumpeters, guan, curassow, parrots, parakeets and toucans. It is recommended to conduct faunal surveys in the EXRES, at various locations, to specify the existing fauna and especially to check the impact of hunting on wildlife, assessing its sustainability. (BRAZIL, 2014, p. 28).

Since ROP EXRES is an environmental protection unit, it is very common to find these animals near the residences of extractivists, so it is important to know how to handle them, for the safety of the community and especially of the animals. There are several reports on the subject, through the testimony of residents, according to the record of the management plan itself:

During field research, in May 2009, the residents had cited the slaughter of some wild animals that were preying on the residents' own domestic animals. Among them, several birds of prey (hawks and eagles), some felines (jaguar, wild cat), and more rarely bush dogs and small foxes were cited. The preventive killing of snakes (anaconda- *Eunectes murinus*; boa constrictor) was also mentioned. The killing of a harpy eagle, a species that is vulnerable to extinction, was also mentioned, along with the occurrence of this species in the lower Rio Ouro Preto communities, indicating the urgency of environmental

education and access to information on-site. (BRAZIL, 2014, p. 80).

Wildlife management practices are a way to not hurt wild animals, to decrease hunting of endangered species, and also to promote an ecological balance. A publication from the state of Paraná stresses maintaining this balance: Animals have important roles in maintaining the balance in nature. They disperse seeds, "planting" trees, control populations of species when in excess which can be harmful to our crops and livestock, and also produce important medications for the cure of many diseases. Every small animal has its specific function in nature and its absence entails incalculable damage to mankind. (PARANA, 2018, p. 1).

TYPE 4 b.6) Improve agricultural practices, increasing sustainability, productivity and adding value to Exres products - PROTECTION AND CONSERVATION

The predominant economic activity in ROP EXRES is agriculture focused on cassava plantations, for the manufacture of cassava flour sold in the local market. Improving agricultural practices can cause a positive jump in income for extractivists; in this sense the following is understood:

A set of principles, standards and technical recommendations applied to the production, processing and transportation of food, oriented to take care of human health, protect the environment and improve conditions for workers and their families. (FAO, 2007, p. 6).

Sustainable agricultural practices can promote protection when they aim to conserve soil and water, reduce the use of pesticides, increase the quality of the cultured product, and increase the possibility of entering new markets that monitor for sustainability.

TYPE 4 b.8) Improve the income of extractivists through the sustainable management of timber - PROTECTION AND CONSERVATION

It has been cited that the main income for extractivists comes from agriculture, while other sectors with

economic potential are forgotten, or are not developed due to lack of knowledge and investment by the Exres administration. One way to diversify economic activities would be sustainable management of timber, using several techniques in order to exploit natural resources, aligned with sustainability, through protection of the trees that need not be removed.

ROP EXRES has areas that can be exploited; however, illegal logging is increasingly affecting the prevalence of timber with high economic value in the market. The consequences are contained in the management plan:

On the dry land flank situated between the lowland and upland, generally flat, sandy, low in humus, in high leaching process, low fertility, there is a scarce volume of "hard" wood (the species which usually have economic value). (BRAZIL, 2014, p. 28).

The sustainable management of timber is a way to reduce deforestation and generate a source of income for the residents of the unit.

TYPE 4 b.9) Involve stakeholders from Guajar Mirim in a sustainable ecotourism experience that strengthens the culture of forest peoples through the principles of solidarity, cooperation and care for the earth - PROTECTION AND CONSERVATION

Since it presents unique biological diversity, the development of ecotourism in ROP EXRES is one of the issues addressed in the management plan. The appreciation of its natural beauty through ecotourism is

TYPE 5 - MANAGEMENT AGREEMENT OBJECTIVES

Table 20 - Indicators "protection" and "conservation" present in "TYPE 5 - MANAGEMENT AGREEMENT OBJECTIVES" in the 2014 ROP EXRES management plan.

TYPE 5 - MANAGEMENT AGREEMENT OBJECTIVES in the management plan	Present Indicators: 1) PROTECTION and 2) CONSERVATION
a) To ensure the self-sustainability of the Exres by regulating the use of resources and behaviors to be followed by its residents;	2) CONSERVATION
b) To express to ICMBio the commitment of EXRES residents to comply with environmental legislation and at the same time offer a verification tool of compliance of norms that is accepted by all.	-

Preparation: Luciana Fabiano.

By uniting the objectives of subprograms with strategic planning, the strategic objectives of the extractive reserve were defined, based on the methodology adapted from the "Balanced Scorecard". This methodology allows the strategy to be developed based on five (5) keywords: Impact, Result in, Do, Be and Have, encompassing society, extractivists (beneficiaries), administrative processes, learning and resources.

The protection and conservation of biodiversity are inserted in the objectives of the 2014 ROP EXRES management plan through the following strategic objectives:

seen as an alternative to generate income for the community, as opposed to the model that generates profit from agriculture and logging. Santos presents some benefits of ecotourism for these populations:

Ecotourism is a segment of tourism that uses, in a sustainable manner, natural and cultural heritage, encourages its conservation and seeks the formation of environmental awareness through the interpretation of the environment, promoting the well-being of the population. (SANTOS, 2012, p. 12)

Ecotourism is growing a lot, but although SNUC itself has as its objective to promote eco-tourism, its development encounters many difficulties due to the lack of standards that regulate the implementation of tourism in environmental protection units.

XII - to foster conditions and promote environmental education and interpretation, recreation in contact with nature and eco-tourism. (BRAZIL, 2000, p. 2).

Ecotourism promotes environmental protection by bringing together leisure and environmental education; through its activities it shows the value of nature and the importance of preserving biodiversity.

It enables effectiveness and efficiency in economic activity, while maintaining the diversity and stability of the environment, acting as a tool that can guide, bring awareness and balance between the damage caused by economic development and the need to preserve the environment. (KRAEMER, 2005, p. 1)

TYPE 6 - STRATEGIC OBJECTIVES

Table 21 - Indicators "protection" and "conservation" present in "TYPE 6 - STRATEGIC OBJECTIVES FROM THE BSC METHOD" in the 2014 ROP EXRES management plan.

Keyword	TYPE 6 - STRATEGIC OBJECTIVES FROM THE BSC METHOD	Present Indicators: 1) PROTECTION and 2) CONSERVATION
Impact	1 To be recognized for their environmental services	2) CONSERVATION
	2 Constitute a barrier to deforestation in Rondônia	1) PROTECTION
	3 Allow the continuity of man in the forest	-
Result in	4 Enable access to electricity	-
	5 Improve the income of Beneficiaries	-
	6 Improve communication between communities and the city	-
	7 Ensure access to education	-
	8 Ensure access to health care	-
	9 Ensure adequate transportation	-
Do	10 Settle the Land situation	1) PROTECTION
	11 Facilitate the PMFS	1) PROTECTION 2) CONSERVATION
	12 Lobby with the government and other organizations	-
	13 Promote improvement of the rubber and Brazil nut productive chains	-
	14 Establish partnerships to improve agricultural practices	2) CONSERVATION
	15 Implement a community-based tourism plan	-
Be	16 To develop the technical and managerial competence of the staff with a focus on conflict management, GIS, land tenure, traditional populations, protected area management, and public policies for the target population.	1) PROTECTION
	17 Promote training for beneficiaries in the following areas: administrative organization, forest management, farming techniques, Brazil nuts and rubber.	1) PROTECTION 2) CONSERVATION
Have	18 Expand the number of collaborators and employees	-
	19 Access financial resources from the central administration and capture alternative sources (ICMBio)	-
	20 Obtain administrative and financial self-sustainability (associations)	-

Preparation: Luciana Fabiano.

4.2 QUESTION "B" FROM "MODULE 6 - OBJECTIVES" IN THE RAPPAM METHOD: ARE SPECIFIC GOALS RELATED TO BIODIVERSITY CLEARLY EXPRESSED IN THE MANAGEMENT PLAN?

The indicator of question "B" from "Module 6 - Objectives" of the RAPPAM method is "biodiversity". The RAPPAM method seeks to diagnose whether or not "specific objectives related to biodiversity are clearly stated in the management plan." In order to analyze the 2014 ROP EXRES Management plan the possibility of four (4) existing variables were considered in order to answer that question:

- variable 01 - consider only "Type 1 - Specific Objectives" from the six (6) types of objectives found in the management plan and identify which of these specific objectives related to biodiversity are clearly expressed (**directly, objectively**) and which of them relate to the biodiversity, but are not clearly expressed (make mention **indirectly, are implied**) in the management plan;
- variable 02 - consider all six (6) types of objectives at once, found in the management plan and identify which ones are specifically related to biodiversity (**directly, objectively**), i.e. they are clearly expressed;
- variable 03 - consider all six (6) types of objectives at once, found in the management plan and identify which ones are specifically related to biodiversity, but are not

clearly expressed (contained in an **indirect** way, i.e., are **implied**).

Among the possible variables, the last, variable 03 was discarded from the analysis since according to the wording of the question the term "specific" is opposed to the term "implied". If it is specific it cannot be implied. The term "specific" has the connotation of being uniquely and directly related to biodiversity. So it could not refer to others, even if this other were included under "biodiversity". But the term "implied" denotes "that which is inferred, but was not said or written." That is, it was necessary to talk or write about something else, no longer making it "exclusive".

The result obtained from the above-mentioned variables was as follows:

a) Variable 01:

Table 22 - Indicator "Biodiversity" present directly and indirectly in "Objective Type 1 - Specific Objectives" - Variable 01.

TYPE 1 - SPECIFIC OBJECTIVES of the Management plan	Biodiversity expressed directly (objective) or indirectly (implied)
a) Ensure free work area for the extractivists with no bosses	-
b) Avoid invasions in the Exres area	-
c) Preserve the native forest	Implied
d) Ensure the sustainable use of natural resources	Implied
e) To promote access to education and health care for beneficiaries	-

Preparation: Luciana Fabiano.

Nothing related to biodiversity was found in the specific objectives, which were clearly stated in the management plan.

b) Variable 02:

Table 23 - Indicator "Biodiversity" present directly and indirectly in "6 Types of Objectives" that exist in the management plan - Variable 02.

TYPES OF OBJECTIVES that exist in the management plan	Biodiversity expressed directly (objective) or indirectly (implied)
a) Type 1 - Specific	-

objectives related to the ROP EXRES CU;	
b) Type 2 - General Objective concerning the general program "Environmental and Socioeconomic Sustainability Programs " (PSAS) of the Unit;	-
c) Type 3 - "Common" Objectives referring to the programs contained in the aforementioned general program;	-
d) Type 4 - "Common" Objectives referring to those subprograms contained in the programs that make up the PSAS;	-
e) Type 5 - "Common" Objectives for the "Management Agreement";	-
f) Type 6 - Strategic Objectives relating to the subprograms ("d" above).	-

Preparation: Luciana Fabiano.

As in the variable 01 analysis, variable 02 does not present any specific goals related to biodiversity that have been clearly stated in the management plan. To be objective, the indicator "biodiversity" was only found six (6) times throughout the entire management plan, a number considered insufficient to emphasize the importance that the term connotes. The indicator "biodiversity" appears in the following locations of the management plan:

- a) In the presentation (p. 9) - 1 time.;
- b) In the introduction (p. 10) - 1 time.;
- c) In Section 3 entitled "Characterization of the Unit" (p. 15; 16) - 2 times;
- d) In the "Research" subprogram (p. 133) - 1 time.;
- e) In the conclusion (p. 145) -. 1 time.

In the introduction of the management plan, it stresses the importance of the document for the conservation of biodiversity in the CU, and it is true that biodiversity is important not only for ROP EXRES, but also for society as a whole, for nature, for the environment in general and for the world. Regarding the theoretical scope of the term "biodiversity", see some considerations about its conceptual basis below.

Biodiversity or biological diversity is all forms of life found on Earth, from microscopic beings like a bacterium to a jaguar (the largest feline in the Americas), so it is a term often used by people concerned with protecting the lives of these beings, avoiding their disappearance.

According to Law no. 9985 from 2000, which created the National System of Conservation Units (SNUC), biodiversity is:

The variability of living organisms from all sources including, among others, terrestrial, marine or other aquatic ecosystems and the ecological complexes of which they are part; further comprising diversity within species, between species and of ecosystems (BRAZIL, 2000, p. 1).

According to Barbieri, a professor from the University of São Paulo, and oceanographer with licensure in biological oceanography, biological diversity can be defined as:

The variety of life on Earth, including the genetic diversity within populations and between species, the variety of species of flora, fauna, macroscopic fungi and micro-organisms, the variety of ecological functions performed by organisms in ecosystems and the variety of communities, habitats and ecosystems. (BARBIERI, 2010 p. 7).

They correspond to all forms of life (animal and plant), including genetic variation within populations and between species, their habitats, ecosystems, and ecological processes, all of which are dependent on one another (Barbieri, 2010).

The complex interaction of different species in a natural and continuous cycle should be seen as an inseparable system that benefits all components of nature, including humans. Thus, it is important to protect biodiversity; a small change in this cycle endangers the whole system and can have serious consequences, such as the disappearance of a species.

In the ranking analysis² generated in part by the ROP EXRES community, based on the five priority objectives, those chosen related to biodiversity represent the smallest sum of the 67 (sixty-seven) points. When items aimed at the preservation and conservation of biodiversity are taken by themselves, environmental devaluation is noticeable, since of the 264 (two hundred and sixty-four) points from the entire table, only 67 (sixty-seven) of those points are related to biodiversity, and even then, indirectly so.

Table 4 - Subprograms directed towards the protection and conservation of biodiversity.

SUBPROGRAMS	POINTS
5 Sustainable Forest Management Plan	18
6 Payment For Environmental Services	17
7 Agricultural Practices	16
11 Training Courses	11
19 Recovery of Degraded Areas	2
20 Protection and Control	2
21 Wildlife Management	1
22 Exres Management	0
Total	67

Source: Adapted from the 2014 ROP EXRES management plan

From the point of view of JEROZOLIMSK (2013) the EXRES should cease to be seen as an area for environmental protection alone, but also as an organization that needs to present satisfactory results, benefiting the local community, users of the reserve and society in general without harming the EXRES's biodiversity.

Through analysis of the 2014 ROP EXRES management plan, in answering the first question of the RAPPAM questionnaire, the inclusion of objectives related to protection and conservation of biodiversity was observed. However, in relation to the second question regarding whether or not "the specific objectives related to biodiversity are clearly stated in the management plan," analysis revealed a negative response.

In order to make these objectives more clear or to include certain new objectives, those found in art. 4 of law no. 9985/2000 can be used as a model, adapting them according to the needs of the unit. For example:

- Protect species that are threatened with extinction at the regional and national levels;
- Take protective measures for the reserve's biodiversity;
- Recover degraded areas in order to restore biodiversity;
- Promote and encourage scientific research on biodiversity
- Value the traditional population and their knowledge related to local biodiversity.

It is important to clarify the protective measures of biodiversity against human activities, on extinct and endangered species; protecting biodiversity is protecting the quality of life of living beings, as a supplier of indispensable resources previously mentioned such as water, wood and food, as well as being essential for the

² Table 2, page 22 of this production.

maintenance of the ecological balance. Leaving its protection implied, as it currently is in the ROP EXRES management plan, devalues its importance for the local community, the reserve's direct beneficiaries, depriving extractive culture and the creation of the sustainable use protection unit.

ROP EXRES has an area of 204,583 hectares with various species habituating within it; Table 5 shows some examples of the biodiversity:

Table 5 - Examples of biodiversity in the ROP EXRES

Fauna	Flora
Macaw	Acai
Cotia	Copaiba
Tapir	Pitch
Jatuarana	Maparajuba
Peacock bass	Arapari
Peccary	Maracatiara

Source: Adapted from the 2014 ROP EXRES management plan

These are just a few among the many species found on the reserve; thus, a recommendation in the management plan of the execution of a study to accurately identify all the species that make up its fauna and flora is essential, since this will emphasize the impact of the loss of this biodiversity to the world.

As an example of specific objectives related to biodiversity clearly expressed, those established by the Rio Cautário Federal Extractive Reserve in its management plan can be cited:

- Protect the natural resources necessary for the subsistence of traditional populations, such as the Brazil nut (*Bertholletia excelsa*), the rubber tree (*Hevea brasiliensis*), copaiba (*Copaifera langsdorffii*), among others;
- Preserve the EXRES's natural resources and biodiversity for provision of ecosystem services such as a carbon reserve, cycling nutrients (fertilizer), maintenance of biological diversity, maintenance of an environmental balance, provision of food, among others;
- Foster the development of research on the conservation of biodiversity, natural resources and cultural appreciation of beneficiary families in the EXRES
- Protect the EXRES's chelonians through a specific management program, aiming to contribute to the conservation of different species that exist in the CU (BRAZIL, 2017, p. 279).

The above objectives are easily identified since they make clear their claim in relation to biodiversity, including, in fact, the protection of a specific animal, the chelonian; but it is not enough to protect the biodiversity, since it restricts its field of operation.

The management plan for ROP EXRES, even after identifying the non-occurrence of the appearance of the tapir (*Tapirus terrestris*), included in the list of endangered species, did not include the protection of this or other species among its objectives, such as the peccary (*Tayassu pecari*), another endangered animal. A survey of endangered species could have been done, and their protection and proliferation could have been defined as a specific objective.

The same RAPPAM method that can serve as a guide to develop objectives related to biodiversity since it assesses their biological importance, quantifies endangered or non-endangered species, including those hunted by extractivists themselves, among other issues. RAPPAM also identifies opportunities and threats in order to ultimately determine the targets most in need of attention.

4.3 QUESTION "C" FROM "MODULE 6 - OBJECTIVES" OF THE RAPPAM METHOD: ARE THE PLANS AND PROJECTS CONSISTENT WITH THE OBJECTIVES OF THE CU?

The 2014 ROP EXRES management plan contains several quotes on plans and projects. It refers to some key projects upon the creation of the reserve, regarding occupation of the territory in which it is located, before it was transformed into a natural protected area, more specifically, before it was transformed into an extractive reserve.

In addition to these aforementioned plans and programs, others are contained in the management plan, executed or not, prior to publication of the 2014 ROP EXRES management plan 2014. These passages are portrayed in other published works such as those by Moret (2005) and Ferreira (2009):

In order to organize the agro-extractive productive process in productive units in ROP EXRES, some agroextractivists, along with the Guajar Mirim bank made possible funding from the National Program for Strengthening Family Agriculture (PRONAF). (MORET, 2005, p. 11).

According to Ferreira (2009), for the purpose of strengthening agroextractivism as an alternative to generate income and improve quality of life, it is understood that various efforts were channeled to ROP EXRES, among them: subsistence farming, the extraction

of acai, of Brazil nuts, of rubber and planting cassava for the production of its flour. Prevalent in all communities, a small part of the cassava flour production is sold in Guajará-Mirim-RO, contributing to the domestic economy.

In order to promote the development and strengthening of the reserves, agroextractivism programs were developed, from which some residents of ROP EXRES benefited, such as:

- a) Monitoring and structuring of production and transportation;
- b) Ecotourism;
- c) Rubber;
- d) National Program for Strengthening Family Agriculture (PRONAF);
- e) Beekeeping,
- f) Nurseries for the Agroforestral system;
- g) Use of babassu to generate electricity;
- h) Seed collection;
- i) People's Production Center: production of bio-jewels and crafts; use of by-products of the production chain of babassu, native fruit pulps;
- o) Creation of the Agroextractive Energy Cooperative. (FERREIRA, 2009, p. 47).

The projects listed above have been developed over the years, but not all achieved the expected goals. (FERREIRA, 2009)

The object of this study is concerned with the analysis of the objectives contained in the management plan for the reserve. The methodological tool of analysis consists of six (6) questions from the RAPPAM method, a questionnaire internationally applied by various countries to assess the effectiveness of protected area management. In this sense, the plans and projects targeted in question "C" from "Module 6 - Objectives" of the RAPPAM method, are those contained in the management plan, but that establish relationships with the reserve's goals. Therefore, plans and projects that have no connection with the PA's objectives were excluded from the analysis, such as those discussed earlier under this subheading.

It is necessary to record the scope of the meaning of the words "plan" and "project," which are the indicators present in question "C" from "Module 6 – Objectives," prior to analysis.

There is a hierarchical relationship between the words "planning," "plan" and "project". The first is the mental visualization, oral discussion and exploration of ideas: why, how, where, when, what, and who should achieve an objective. The second is the realization of this planning, concretized by the written production of a document that records everything that makes up the planning. It is also

known as a program. The last term, project, is a technical, detailed and comprehensive document of how the plan will be put into practice. It is the step by step execution, the procedures to be performed; it consists of a linguistic approach in the future. For this reason, there may be as many projects as there are ideas that come out of planning as indicated in the plan. Finally, it can be said that planning is the theory, the plan or program is the method, and the project is the practical guideline.

The Infopédia dictionary defines the word "plan" as: "all the provisions necessary to implement a project; program." (Infopédia, 2019).

According to the Michaelis dictionary a "plan" is the "set of scheduled operations for a particular purpose", and is defined again as a "program involving government measures to achieve an objective" (Michaelis, 2019).

According to Menezes, a 'project' is a unique development that should present a clearly defined beginning and end and that, when driven by people can achieve their goals while respecting deadlines, cost and quality (Menezes, 2001).

In turn, Vargas (2009) states that a "project" is a non-recurring development, characterized by a clear sequence and logical events, with a beginning, middle and end, which is intended to achieve a clear and defined objective, being led by people within predefined parameters of time, cost, resources involved, and quality.

Norm NBR ISO 10006: 2017 regarding "Quality Management - Guidelines for Quality Management in Projects," defines a project as:

A single process performed to achieve a goal.

Note 1 to entry: A project generally consists of a set of coordinated and controlled activities with start and end dates, in accordance with specific requirements, including constraints of time, cost and resources.

Note 2 to entry: An individual project can be part of a larger project's structure and usually has a set start and end date.

Note 3 to entry: In some projects, the objectives and scope are updated and features of the product or service are defined progressively as the project progresses.

Note 4 to entry: The output of a project may be one or several units of product or service.

Note 5 to entry: A project's organization is usually temporary and established for the project's lifetime.

Note 6 to entry: The complexity of the interactions between a project's activities is not necessarily related to the project's size. (ISO, 2017, p. 2)

Based on the above concepts, it is assumed in this paper that the word "programs" used in the 2014 ROP EXRES management plan has the same meaning as the indicator "plans", present in question "C" of "Module 6 - Objectives" from the RAPPAM method. I.e., "plans" and "programs" are equivalent in the following analysis.

In order to answer question "C" of "Module 6 - Objectives" from the RAPPAM method, analysis of the 2014 ROP EXRES management plan found six (6) plans,

five (5) projects, one (1) general program, 5 (five) programs and 21 sub-programs, which are presented below.

4.3.1 Plans

Plans found related to the ROP EXRES management plan's objectives were as follows:

Table 24 - Plan for Sustainable Forest Management

1 Plan for Sustainable Forest Management	Chapter	4 Contents of the management plan: management unit
	Subtitle	4.3 Management Agreement
	Item 21 of the Management Agreement	21 The exploitation of timber products is allowed based on the preparation of a Plan for Sustainable Forest Management
	Page	110
	Chapter	4 Contents of the management plan: management unit
	Subtitle	4.7 Environmental and Socio-Economic Sustainability Programs of the Unit
	General program	PSAS
	Program	4.7.2 Natural Resources and Productive Chains Management Program
	Subprogram	Timber products
	Priority actions	Develop Plan for Sustainable Forest Management, focusing on commercial purposes of timber.
	Page	132

Preparation: Luciana Fabiano.

Table 25 – Non-Timber Related Forest Management Plan

2 Non-Timber Related Forest Management Plan	Chapter	4 Contents of the management plan: management unit
	Subtitle	4.3 Management Agreement
	Priority actions	Forest products such as fruits, oils and essences can be extracted for consumption by residents. Their marketing, along with the use of other products, upon approval of this Agreement may be carried out by the locals, in a traditional manner and/or as set forth in the Non-Timber Related Forestry Management Plan.
	Page	110

Preparation: Luciana Fabiano.

Table 26 - Business Plan and Economic Feasibility of Sustainable Tourism

3 Business Plan and Economic Feasibility of Sustainable Tourism	Chapter	4 Contents of the management plan: management unit
	General program	PSAS
	Program	4.7.2 Natural Resources and Productive Chains Management Program
	Subprogram	Tourism
	Priority actions	Prepare the Business Plan and evaluate the Economic Feasibility of Sustainable Tourism.
	Page	133

Preparation: Luciana Fabiano.

Table 27 - Communications and Marketing Plan

4 Communications and Marketing Plan	Chapter	4 Contents of the management plan: management unit
	General program	PSAS
	Program	4.7.2 Natural Resources and Productive Chains Management Program
	Subprogram	Tourism
	Priority actions	Prepare the Communications and Marketing Plan
	Page	133

Preparation: Luciana Fabiano.

Table 28 - Annual Action Plans

5 Annual Action Plans	Chapter	4 Contents of the management plan: management unit
	Subtitle	4.8 Strategic Planning
	2nd sentence of the 2nd paragraph	In order for this management plan to be put in practice it is necessary that the unit use it properly, detailing the actions proposed in the Annual Action Plans
	Page	136; 142

Preparation: Luciana Fabiano.

Table 29 - Community-Based Tourism Plan

6 Community-Based Tourism Plan	Chapter	4 Contents of the management plan: management unit
	Subtitle	4.8 Strategic Planning
	Subtitle	4.8.2 Strategic objectives and strategic map
	Subtitle	Internal Processes (Do)
	Strategic objectives	Implement Community-Based Tourism Plan
	Page	140; 144

Preparation: Luciana Fabiano.

4.3.2 Projects

The projects found that are related to the objectives of the ROP EXRES management plan were as follows:

Table 30 - Project for Production and Sale of Seedlings

1 Project for Production and Seedling Sale Of	Chapter	4 Contents of the management plan: management unit
	General program	PSAS
	Program	4.7.2 Natural Resources and Productive Chains Management Program
	Subprogram	Other Extractive Products
	Priority actions	Support the planting of single and groups of acai plants, as well as the development of a project for the production and sale of seedlings.
	Page	129

Preparation: Luciana Fabiano.

Table 31 – Projects for the Collection and Management of Seeds from Native Forest Species for Sale

2 Projects for the Collection and Management of Seeds from Native Forest Species for Sale	Chapter	4 Contents of the management plan: management unit
	General program	PSAS
	Program	4.7.2 Natural Resources and Productive Chains Management Program
	Subprogram	Other Extractive Products
	Priority actions	Support projects for the collection and management of seeds from native forest species for sale
	Page	129

Preparation: Luciana Fabiano.

Table 32 - Fish Farming Project Using Species Native from the Region

3 Fish Farming Project Using Species Native From the Region	Chapter	4 Contents of the management plan: management unit
	General program	PSAS
	Program	4.7.2 Natural Resources and Productive Chains Management Program
	Subprogram	Fishing resources
	Priority actions	Ascertain, through local studies, the potential for and viability of native fish farming projects in the region through net pens in stretches of the Rio Ouro Preto where the practice is possible or through dugout ponds. Especially for the species: Tambaqui, Piau and Jatuarana
	Page	130

Preparation: Luciana Fabiano.

Table 33 - River Repopulation Project

4 River Repopulation Project	Chapter	4 Contents of the management plan: management unit
	General program	PSAS
	Program	4.7.2 Natural Resources and Productive Chains Management Program
	Subprogram	Fishing resources
	Priority actions	Prepare and execute the river repopulation project through the breeding and release of fingerlings into the river
	Page	131

Preparation: Luciana Fabiano.

Table 34 – Planting Project for Marketing and Commercial Management of Native Timber

5 Planting Project for Marketing and Commercial Management of Native Timber	Chapter	4 Contents of the management plan: management unit
	General program	PSAS
	Program	4.7.2 Natural Resources and Productive Chains Management Program
	Subprogram	Timber products
	Priority actions	Seek support for the development of a planting project for marketing and commercial management of previously planted native timber
	Page	132

Preparation: Luciana Fabiano.

4.3.3 Programs

The programs found related to the ROP EXRES management plan objectives were as follows: one (1) general program, five (5) programs and 21 (twenty-one) subprograms, which will henceforth be described.

Table 35 - General Program, programs and subprograms found in the 2014 ROP EXRES management plan that are related to the CU's objectives.

PROGRAM AND SUBPROGRAMS	OBJECTIVES OF THE PROGRAMS
I GENERAL PROGRAM - ENVIRONMENTAL AND SOCIOECONOMIC SUSTAINABILITY PROGRAMS OF THE UNIT- PSAS	
I Quality of Life and Citizenship Program - divided into nine (9) subprograms:	
1.1 Health Subprogram	Ensure the basic right to health care for the residents of the Exres.
1.2 Education Subprogram	Ensure the right to education for residents of the Exres.
1.3 Housing/living arrangements Subprogram	Improve the quality of the housing for beneficiaries of the Exres.
1.4 Sanitation Subprogram	Improve the quality of life of residents of the Exres through disease prevention.
1.5 Communication Subprogram	Improve communication between communities and municipal headquarters.

1.6 Culture Subprogram	Promote recovery of the culture and identity of the Exres population.
1.7 Leisure and Sport Subprogram	Encourage the practice of soccer and championships in the Exres.
1.8 Energy Subprogram	Provide electricity to all residents of the Exres.
1.9 Transportation and Access Subprogram	Ensure good access to and provide regular transportation to all Exres communities
2 Natural Resources and Supply Chains Management Program - divided into ten (10) subprograms:	
2.1 Rubber Subprogram	Add value to, improve the quality of and income from rubber tapping.
2.2 Brazil Nut Subprogram	Add value to and improve the product quality of Brazil nuts.
2.3 " Other Extractive Products" Subprogram	Improve the income of Exres beneficiaries through the commercialization of sustainable extractive products.
2.4 Wildlife Management Subprogram	Sustainably and adequately manage species of wild fauna from the Exres that are causing damage to communities.
2.5 Fishery Resources Subprogram	Assess and facilitate breeding of native fish in the Exres for consumption and marketing.
2.6 Food Safety Subprogram - Agriculture	Improve agricultural practices, increasing sustainability, productivity and adding value to the products of extractive reserves.
2.7 Food Safety Subprogram - Animal Husbandry	Improve nutrition and income of Exres beneficiaries.
2.8 Timber Products Subprogram	Improve the income of extractivists through the sustainable management of timber.
2.9 Tourism Subprogram	Involve stakeholders from Guajar Mirim in a sustainable ecotourism experience that strengthens the culture of forest peoples through the principles of solidarity, cooperation and care for the earth.
2:10 Research Subprogram	Promote the development of research within the CU, in various areas of study.
3 Degraded Area Recovery Program	
Does not have any subprograms	
4 Environmental Monitoring and Protection Program	
Does not have any subprograms	
5 Management and Administration Program - divided into two (2) subprograms:	
5.1 Infrastructure and Personnel Subprogram	Provide the Exres with adequate infrastructure and staff, as well as forming strategic partnerships to promote sound management of the CU, in order to enable the other subprograms.
5.2 Land Tenure Subprogram	Consolidate the land tenure for full implementation of the management plan.

Preparation: Luciana Fabiano.

Based on the concepts of the indicators "plans" and "projects", presented earlier in this section, the analysis reveals consistency between them and the ROP EXRES's objectives. The assertion is based on the wording of the text that makes up the objective. The management plan is detailed when appointing its "plans" and "projects" - in the above table called "programs" and "subprograms" respectively. The text goes beyond the indication and characterization of plans and projects, referencing some goals to be achieved with the "strategic objectives", which are by-products of the projects' (subprograms) objectives, as follows:

Construction of the strategic objectives was carried out, firstly, by prioritizations put forth by Community

participants at the workshop, and also based on the objectives of subprograms of environmental and socio-economic sustainability. [...] The objectives of high priority subprograms were transformed into strategic objectives. (BRAZIL, 2014, p.137; 138)

These strategic objectives were formulated based on the objectives of the PSAS program, its five (5) programs and 21 (twenty-one) subprograms.

4.4 QUESTION "D" FROM "MODULE 6 - OBJECTIVES" OF THE RAPPAM METHOD: DO THE CU'S EMPLOYEES AND DIRECTORS OF UNDERSTAND THE OBJECTIVES AND POLICIES OF THE CU?

During field research it was found that ROP EXRES has only one employee, Mr. Albino Batista Gomes, named as head of the unit by ordinance no. 899/Civil House, of May 14, 2015; Albino has a degree in Business from the "Integrated College of the Central Plateau Educational Union" and in Environmental Engineering from "Salgada de Oliveira University." (UNIVERSE).

He has extensive experience in working in protected areas, and since he was appointed to serve in ROP EXRES has been fighting to protect the unit; proof of this are the various operations in which he participates, such as the operation against illegal extraction of ore which was happening on the reserve.

The chief of the reserve's work and effort are recognized by those with which the partnership is indispensable (environmental police and IBAMA) for execution of his work. Based on his experience and work performed, it is clear that the manager understands the unit's objectives and policies, and the importance of their performance for the socioeconomic development of ROP EXRES.

In addition to his training and experience as a manager, it should be taken into consideration that according to RAPPAM, in the period between 2005 and 2006, more than 83% (eighty-three) understood the CU's objectives and policies, while in 2010 this index rose to 92% (ninety-two).

4.5 QUESTION "E" FROM "MODULE 6 - OBJECTIVES" FROM THE RAPPAM METHOD: DO THE LOCAL COMMUNITIES SUPPORT THE OBJECTIVES OF THE CU?

The 2014 ROP EXRES management plan records in several passages the fact that the objectives are supported by local communities. This is demonstrated by reporting several times over the years, meetings that were held with the community so that the CU's residents could participate in the formulation of the reserve's goals. For example: in 2010 workshops and a general assembly were held, and in 2013 a participatory planning workshop was held.

During the 2013 workshop a representative from each of the communities was chosen (Nova Esperança; Nova Colônia; Ramal dos Macacos; Bom Jesus; Petrópolis; Ouro Negro; Floresta; Divino Espírito Santo; Três Josés; Pompeu; Sepetiba and Nossa Senhora dos Seringueiros). Thus, it became possible to identify the major challenges faced by the reserve in general, taking into account the different characteristics of the communities, in order to ultimately define the plan's fields of action. Each representative, knowing the difficulties of their

community, had the opportunity to choose five (5) subprograms' objectives that meet their priority needs.

The subprograms presented to the extractivists were drafted in accordance with IBAMA's Methodological Roadmap for the Development of Sustainable Federal Extractive Reserve Management Plans (2006). The Roadmap is a reference for the preparation of management plans. It contains the Unit's Environmental and Socioeconomic Sustainability Programs (PSAS), the inclusion or exclusion of which is at the discretion of each protection unit, according to the needs and detected threats. The PSAS of the CU ROP EXRES are:

- a) Quality of Life and Citizenship Program
- b) Natural Resources and Productive Chains Management Program
- c) Degraded Areas Recovery Program
- d) Environmental Monitoring and Protection Program
- e) Management and Administration Program

Each of these programs has subprograms and defined objectives, chosen by the residents as the most important to be achieved in a period of five (5) years. In order to meet the needs of residents, those most affected by the lack of public policies for socio-economic and environmental development of traditional populations, the highest scored objectives are placed in a table, according to the priorities. Several studies advocate the participation of local communities of minority groups such as extractivists, riparians, indigenous peoples and others, in the fight for environmental conservation, combating the loss of biodiversity and the establishment of sustainable practices towards nature. The text by Barros confirms this:

It is essential to know the considerations of this group of local communities and indigenous peoples for the development of the Brazilian strategy of conservation, since the loss of biodiversity directly affects their livelihood, subsistence and culture and they play a key role in its protection and sustainable use (BARROS, 2011, p. 2).

Participation of the local community brings the reserve's goals closer to its embodiment, by taking into consideration beyond the environmental context, the importance of recognizing the lack of community access to education, health, electricity and even communication, because of the distance between ROP EXRES and the urban perimeter of the city, and the distance from one location to another within the unit itself. With regards to bringing PA communities and Exres' objectives closer together:

Preparation of a management plan in close dialogue with society, particularly those directly affected in some way by the presence of the CU, provides an opportunity to put into practice the principles of an ecosystem approach, as proposed by the CBD. This also expands social control over the creation and implementation of public policies and is reflected in the insertion of the CU in their socioeconomic context. It allows, in this way, the protected area, to comply with the SNUC Act's objectives and the performance of a relevant role in promoting development - social and economic - local and regional. (ICMBIO, 2013, p. 19)

Local community participation in the preparation of a management plan is guaranteed by the law established by SNUC and IN No. 7/2017/ICMBIO, which guarantees not only the community's participation, but also that of environmental agencies, researchers and unit managers. Each can have an opinion with a different perspective and contribute to drawing up the plan and its objectives.

IN No 7/2017/ICMBIO establishes the specifics of extractive reserves, sustainable development reserves and other sustainable use protected areas that are home to traditional communities. See some of its additional principles and guidelines:

- a) recognition, appreciation and respect for environmental and cultural diversity of traditional communities and their economic, social and cultural organization systems;
- b) recognition that traditional territories are protected spaces of social, cultural and economic reproduction of traditional populations;
- c) ensuring the necessary and appropriate means for the effective participation of traditional populations in decision-making processes and their role in the planning and management of extractive reserves and RDS, as indicated by the Governance Group;
- d) recognition and appreciation of different forms of knowledge, especially the knowledge and practices of traditional populations;
- e) the obligation to seek to improve the quality of life of traditional populations, access to basic services and citizen rights, respecting their specificities and socio-cultural characteristics; and
- f) consider that traditional and extractive practices constitute historical processes subject to adjustments, innovation and incorporation of new technologies, respecting the attributes of sustainability and providing ethnodevelopment. (BRAZIL, 2017, p. 6)

Participation of the local community is vital to operational planning, since just by knowing the greatest needs of extractivists it would be possible to develop coherent and tangible planning. However, this does not guarantee that the objectives are achieved, because this depends not only on communities and ICMBIO, but the coordination and integration of these entities with the government, along with a number of factors and social actors working together to overcome the lack of human and financial resources. The objectives must be supported by and developed with community participation, because the unit's residents will be largely affected if the objectives are poorly formulated.

4.6 QUESTION "F" FROM "MODULE 6 - OBJECTIVES" FROM THE RAPPAM METHOD: DO THE MEMBERS OF THE CU'S MANAGEMENT BOARD UNDERSTAND THE OBJECTIVES AND POLICIES OF THE CU?

As provided for in SNUC's Law No. 9985 from July 18, 2000, the management of ROP EXRES should be administered by a "Governing Council" chaired by ICMBio with representatives from various agencies and residents of the reserve, chosen by the extractivists themselves.

The "Management Board" of ROP EXRES consists of 26 (twenty-six) members, among main members and alternates. Twelve (12) reserve communities are part of this list: Nova Esperança; Nova Colônia; Ramal dos Macacos; Bom Jesus; Petrópolis; Ouro Negro; Floresta; Divino Espírito Santo; Três Josés; Pompeu; Sepetiba and Nossa Senhora dos Seringueiros. The following are also part of the board:

- a) ICMBIO;
- b) Secretary of State for Environmental Development (SEDAM);
- c) the Municipal Government of Nova Mamore;
- d) National Indian Foundation (FUNAI);
- e) Municipal Secretariat of the Environment (SEMMA);
- f) Federal Bureau of Police in Guajará-Mirim;
- g) Military Police of the State of Rondônia/Environmental Police Battalion
- h) INCRA;
- i) Rural Assistance and Extension Association of the State of Rondônia (EMATER);
- j) Association of Rubber Tappers and Agroextractivists from the Lower Rio Ouro Preto (ASAEX);
- k) Organization of Rondonian Rubber Tappers (OSR);
- l) Association of Rubber Tappers of the Rio Ouro Preto Extractive Reserve (ASROP);
- m) National Council of Extractive Populations (CNS);

n) Association of Açazeiro Agroextractivists of Guajará Mirim (ASAGUAM).

According to Decree No. 4340 from August 22, 2002 the board of a conservation unit must have representations of environmental agencies at the federal, state and municipal levels from distinct areas; in addition, it must also have representatives from the community. Given its importance, it is incumbent upon the management board to:

- a) Seek to integrate the CU with other units as well as specially protected territorial spaces and their surroundings;
- b) Seek to reconcile the interests of various social groups related to the unit;
- c) Evaluate the unit's budget and the annual financial report prepared by the executing agency in relation to the CU's objectives;
- d) Issue an opinion in the case of the advisory board, or ratify, in the case of a deliberative council, hiring and terms of partnership with OSCIP (Civil Social Organization of Public Interest), the shared management hypothesis of the CU;
- e) Monitor management by OSCIP and recommend termination of the partnership agreement, when there are irregularities;
- f) Speak out about work or activity that could potentially cause an impact on the CU in its buffer zone, mosaics or ecological corridors;
- g) Propose guidelines and actions to match, integrate and optimize the relationship with the surrounding population or those living inside the unit, as appropriate. (BRAZIL, 2002, p.3)

According to the aforementioned decree the competence of the management board requires extensive knowledge and understanding of different areas related to the context of an Exres. Based on this statement and in accordance with the passage above, it can be inferred about the understanding of the members of the management board that they do understand and have insight; that is, they understand the objectives and policies of the CU. This conclusion assumes that, any entity that is part of the board needs to act, "*sine qua non*", with some skills of cognitive nature, mentioned by the decree itself,

according to the passage above. However, this does not remain 100% proven. Here's why:

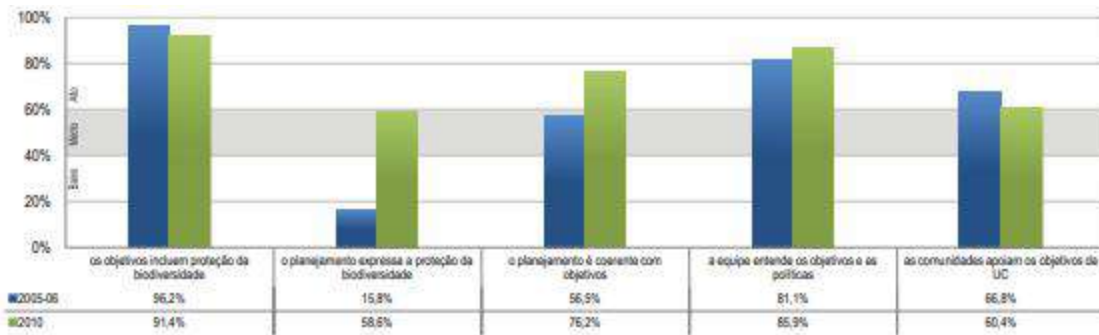
Based on the method used in this study, namely: analysis through RAPPAM method questions of the 2014 ROP EXRES management plan text, the finding that the management council understands the objectives and policies of the Exres seems obvious, since it is considered a required skill as referenced by Decree No. 4340 of August 22, 2002. Therefore, it may be concluded that only people who have the skills broken down by the decree occupy a place in the management council. For a more accurate conclusion, an investigation "in loco" would be needed, through an interview with a representative sample of the directors, to evaluate the understanding of the members of that board.

The continuation of research on the above topic is necessary to complement this assessment. Because here in this study, ascertaining the relevance related to the text of the management plan is sufficient, since the research methodology proposed rests on the analysis of the text produced by the document entitled "2014 ROP EXRES Management Plan".

In addition to the decree as legal framework, in discussing the responsibilities of directors, other theorists emphasize the condition of a management board with skills not only to understand but also to go beyond that, to propose solutions to the problems encountered: the management board shall establish and maintain contact with the community and society involved with the reserve, as well as propose solutions to the problems presented. (Novaes, 2014).

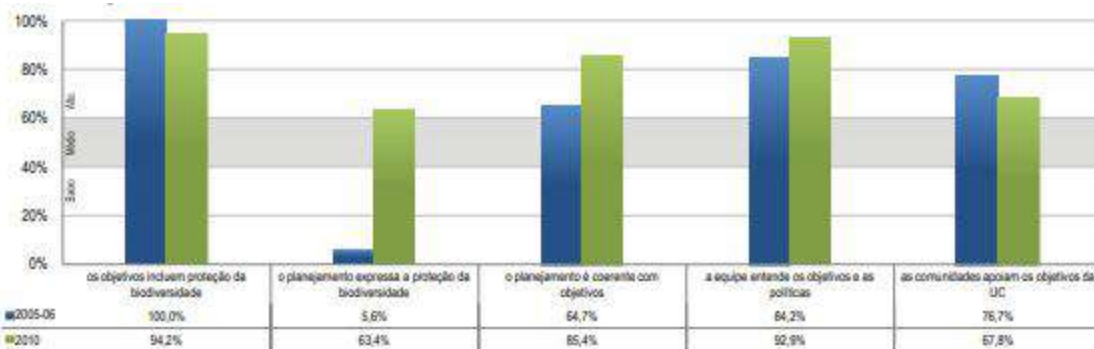
Another source supporting the conclusion that the members of the management board understand the objectives and policies of the Exres is the publication of the results of the assessment performed in sustainable use CUs in all of Brazil and Extractive Reserves in all of Brazil in cycles 2005/2006 and 2010 by WWF, IBAMA and ICMBio using the RAPPAM method. According to RAPPAM:

Graph 2 - Understanding of objectives and policies by the management board - level reached by sustainable use protected areas in 2005 and 2010, according to evaluations applied using the RAPPAM method.



Source: RAPPAM Report cycles 2005/2006 and 2010, p. 46.

Graph 3 - Understanding of objectives and policies by the management board - Index reached by Exres in 2005 and 2010, according to evaluations applied using the RAPPAM method.



Source: RAPPAM Report cycles 2005/2006 and 2010, p. 64.

According to the graphs above, on average more than 80% of management board members understand the goals and policies of the CU. Strengthening the board is one of the biggest and most important challenges that the unit may face; it must be managed with legitimacy, legality and efficiency.

The board is required for the development of the reserve, so it is important that its members have insight into the objectives and policies of the extractive reserve, as well as its environmental laws, to be able to express their opinions clearly and accurately when confronted with the CU's problems, as well as, regarding the community's interests, "interactively participating in the management, considering the management plan, using the plan, the PA's objectives and especially the interests of its residents." (ICMBIO, 2013, p. 16). Despite the directors understanding the PA's objectives and plans, compliance to and meeting the goals and plans leaves much to be desired, as provided for ICMBio itself:

While there is understanding of the purpose and role of the board, perhaps this does not materialize in an

integrated performance and in a way directed to achieving the objectives of protected areas, especially for sustainable use PAs, whose objective is to "reconcile nature conservation with the sustainable use of part of its natural resources. (ICMBIO, 2013, p. 17).

Another aspect, no less important than the understanding of the CU's objectives and policies by members of the management board, also regarding the quotation above from ICMBio is the community's understanding of the board's role in the whole context of extractive reserves. This deficit derives from the scope of the board, inferior acting, poor support and incentives by the additional organs.

As important as it is for the members of the management board to understand the objectives of EXRES and know the extractive reserve, because they are part of its management and must be able to solve the problems faced by it, it is just as important that the CU community itself understand the function council members. It is important for board members to make themselves known, as a way to stand before the subjects

of EXRES, promoting its strengthening and contributing to the development of the CU. The opposite results in lack of community support and weakening the role of the management board before the internal CU population and society as a whole.

V. CONCLUSION

The relevance of this study lies in the fact that the element "objectives" included as part of all protected area management plans, analyzing its characteristics, utilizing questions from an evaluation method used worldwide, a reference to all CUs.

Some intriguing results that were achieved with the study and which deserve to be reported are as follows:

- a) analysis of the management plan allowed for the discovery of different types of objectives in the present document, specifically six (6) types, from which, in all, 53 (fifty-three) objectives were extracted;
- b) in order to identify different types of goals, we suggest some to be more relevant and the others less relevant. Of the six (6) existing types the most relevant are: i) specific, because they are the permanent objectives of the Exres as a whole, and were established since its creation; ii) the "Management Agreement" objectives since they outline rules that affect the entire coexistence of the residents as well as the behavior of visitors throughout the area and around the reserve and iii) strategic, considering that they can be adjusted every five years, according to the needs and changes in the unit. The others:
 - iv) objectives of PSAS,
 - v) objectives of the 5 PSAS programs and
 - vi) objectives of the subprograms are therefore less relevant.
- c) analysis of the ranking of the Exres's priorities³, as chosen by the residents, revealed an important point: 22 (twenty-two) subjects elected in last place the item "Exres Management ". The observation stems from the fact that the viability of all the other 21 subjects comes through the management team and the CU management. This may demonstrate a lack of understanding about the function and role of managers and the scope of the CU's management, which ends up impeding the fulfillment of the proposed objectives;
- d) studying the process that resulted in a ranking of priorities triggering 21 (twenty-one) common objectives of subprograms and twenty (20) existing strategic

objectives in the plan, enabled the discovery of some serious inconsistencies that are present in the management plan:

- Knowing that in the election of ranking priorities the following themes were excluded:⁴i) Leisure and sport; ii) research; iii) infrastructure and personnel; iv) Land tenure;
- Given that in the formulation of the strategic objectives obtained from the BSC method, the following were also excluded:⁵i) Housing/living arrangements; ii) Sanitation; iii) Culture; iv) Wildlife management; v) Fishery resources; vi) Food Safety - Animal husbandry and vii) Timber products; consider the following gaps that were found:

1 - The management plan states that⁶the common objectives of the priority subprograms (ranking) have been transformed into strategic objectives, as a result, it claims that other strategic objectives have been included when preparing the mission and vision (BSC methodology) for the Exres's future, and finally it says that all these items have been presented in a final map (strategic map) of strategic objectives. This sequence implies mistakenly, the idea that there is a single map of strategic goals in place, when in reality the goals of ranking priorities and the objectives obtained by the BSC method are still in force because at no time does the plan undo the claim that they are no longer strategic objectives. In addition to the statement on page 138 of the management plan, regarding whether or not the most prioritized objectives in the ranking have been transformed into strategic objectives, the plan presents the strategic objectives from the BSC method on page 140.

2 - On page 138, while it states that the "most" prioritized subprogram objectives were transformed into strategic objectives of the management plan, it does not mention up to which place of ranking was considered as a criterion for the word "most". In addition, the ranking contains 22 places, the subject of "sanitation" appears in 10th place. However, tables 6 and 7, on pages 52 and 53 of this study (adapted from p. 139 and 140 of the management plan), show that the subject of "sanitation" was excluded from the strategic goals. On the other hand, items "Training courses", "Brazil nuts" and "Tourism" which appear respectively in 11th, 12th and 16th place in the ranking, are set as strategic objectives of the BSC method⁷ and are automatically part of the Strategic Map⁸.

⁴Table 2, p. 10.

⁵Table 7, p. 14.

⁶ Pages 138 and 139 of RESEX Management Plan ROP 2014.

⁷ Page 140 RESEX Management Plan ROP 2014.

³Table 1, p. 09.

How is it possible that the "most" prioritized items do not include that which occupies the 10th place position and yet include items that are up to six places lower than that in 10th place?

e) The plan presents the five (5) PSAS programs and their objectives, except for one: the "Management and Administration Program." This omission of this objective, recorded on page 134 of the plan and 66 of this text, undermines the presented group causing lack of guidance for those who need to use the plan.

Table 11 on page 57, in which the objectives of the five (5) programs under the general PSAS program are presented, shows that the plan omitted the objective of the last program, the "Management and Administration Program". This omission affects the quality of the management plan, in the sense that it is meant to be a complete document about the objectives that guide the ROP EXRES administration. The objectives must be included in the plan as a way to support the understanding of the various segments comprising the administration of a protected area.

f) Page 123 of the management plan states that there are a total of eighteen (18) subprograms, when in reality the text presents 21 (twenty-one).

Below, we present the results the study sought to answer, regarding indicators of 6 questions from the "Objectives Module" of the RAPPAM method, related to the objectives of the sustainable use CU's 2014 ROP EXRES management plan:

5.1 Do the goals of the CU include protection (i1) and conservation (i2) of biodiversity?

By applying the RAPPAM method a lot can be learned about the objectives of a protected area and whether or not it is fulfilling the social function for which it was created in accordance with its own objectives. In this study in particular, the thematic focus were the objectives present in the 2014 Rio Ouro Preto Exres management plan, because it is the official legal document recording this CU's objectives.

Charts 8; 9; 10; 11; 12; 13; 14 recorded on page 56 of this text show that the objectives of ROP EXRES include the indicators "protection" and "conservation" in its management plan. Based on the concepts formulated by the theoretical study on the scope of the meaning of both indicators, the indicator "protection" appeared within the six (6) types of goals and the indicator "conservation" in 5

(five) of them, with only objective "Type 2 - General purpose" missing it.

Currently the Rio Ouro Preto Exres is threatened by the invasions of loggers and deforestation, often caused by the residents themselves, not finding economic alternatives, increasing their agricultural activities in order to survive. Economic alternatives, with basis in conservation, are urgent to facilitate the maintenance of extractive reserves and to defend the forest. Such evidence shows that the future of extractive reserves, and consequently of the extractive model, depends on the search for economic alternatives that can ensure their future sustainability.

CONCLUSION: The indicators "protection" and "conservation" are very well represented in the 2014 ROP EXRES management plan. They mention the different aspects related to the environment when dealing with the PA objectives, although they are not specific on biodiversity.

5.2 Are there specific objectives related to biodiversity (i3) clearly stated in the management plan?

There were no specific objectives related to biodiversity expressed clearly in the management plan. The study revealed that the term "biodiversity" appeared just six (6) times in the full extent of the management plan. In turn, of these six (6) appearances in only one (1) was the term related to one of the existing 53 goals in the entire plan. This relationship is indirect as shown in one of the listed actions to achieve the objective of the PSAS subprogram, "Research", and is not therefore an end in itself, but rather an action to achieve a goal.

Tables 22 and 23 recorded on page 100 of this text identified that none of the goals are "specifically related to biodiversity." The three (3) variables analyzed: 1) "Specific objectives - expressed directly, objective"; 2) "Specific objectives - expressed indirectly, implied" and 3) "All six types of objectives together - expressed directly, objective" revealed that biodiversity was "implied" only, and even then, only in 2 of the 5 goals under "Objective Type 1 - Specific objectives"; the other 5 existing types did not address biodiversity even indirectly.

The objectives were not formulated directly towards biodiversity, but rather were intended for other specific purposes such as strengthening of agriculture and economic development of the extractive community, becoming recognized for providing environmental services and as a barrier to deforestation in Rondonia, among others, but fortunately measures were also taken regarding protection and conservation.

⁸ Page 142 of RESEX Management Plan ROP 2014.

In this context the management plan loses in terms of quality, because it leaves the impression of having left biodiversity as "plan B". Specific objectives are important to define what exactly is to be reached; it addresses the environmental, cultural, social and economic characteristics of the reserve, as well as reporting the reason for the importance of the Exres and the benefits of preserving its resources.

The results of this part of the study allows us to suggest the Cautário River Federal Extractive Reserve as an example of a Management Plan (BRAZIL, 2017, p. 279) in which biodiversity appears clearly expressed; this could be considered when updating the 2014 ROP EXRES management plan and in the preparation and updating of other management plans for any territory.

Clearly stating the specific objectives related to biodiversity allows all stakeholders and society at large to understand them and identify them. It is also an alternative to clarify to residents about the importance of biodiversity; mainly because subprograms related to protection and conservation were those least chosen during the preparation of the Exres's strategic objectives.

One consequence of this factor is the difficulty in assessing the scope of understanding of society about the importance of biodiversity and in taking measures for its protection, since the management plan implicitly states exactly what and how its objectives will work towards protecting.

CONCLUSION: The term "biodiversity" is absent in the 2014 ROP EXRES management plan. The omission and underrepresentation of the term in the management plan affects the CU's objectives as a whole and the master function for which the Exres itself it was created: for the protection and conservation of biodiversity in that space and territory.

5.3 Are the plans (i4) and projects (i4) consistent with the CU's goals?

The study revealed a very positive result regarding this question. After considering the conceptualization of some authors about what is to be and the difference between plans and projects, the methodology applied identified six (6) plans, five (5) projects and over 27 (twenty-seven) items, between programs and subprograms present in the management plan. According to the definition of the concepts presented, the 27 items related to programs and subprograms are equivalent to plans and projects, respectively.

Another result of the study was consistency among plans and projects with the PA objectives. This result was proven by the following tables:

a) No. 24; 25; 26; 27; 28 and 29 starting on page 107 of this text, which revealed the existence of six plans and their relationship to the objectives of ROP EXRES;

b) No 30; 31; 32; 33 and 34 starting on page 108 of this text, which revealed the existence of five projects and their relationship to the objectives of ROP EXRES;

c) No 35 on page 110 of this text, which revealed the presence of 27 more items from plans and programs, as well as the consistency of their language with the objectives of ROP EXRES.

The management plan is very thorough in relation to its plans and projects, including formulating goals and actions necessary to achieve the objectives related to the Exres. Details are one of the necessary characteristics presented by the concepts indicated about plans and projects, which allows us to state what are and are not plans and projects; they demonstrate step by step procedures to reach an end.

CONCLUSION: The indicators "plans" and "projects" demonstrated a wealth of detail about their goals and their applications in the management plan, coming to meet the aspirations of the CU community. These indicators enable the necessary instruments and help residents and other stakeholders to achieve sustainability in the extractive reserve.

5.4 Do CU employees (i5) and administrators (i5) understand the objectives and policies (i6) of the CU?

The study revealed that the CU in question has only one (1) director appointed through a commissioned position, without effective link, designated by appointment as a position of trust who may be appointed and dismissed in accordance with the interests of public administration, and 0 (zero), hired employees.

Another result of this study was the recognition of a frightening reality: the lack of human resources present in ROP Exres, as well as in protected areas in general.

However, it was found that the only Exres administrator, linked to ICMBio, has extensive experience with the management of the studied unit. He has developed numerous managerial nature activities, establishing the bridge between the Exres, its community and society through public and private institutions, organs and sectors; he has been indicated more than once, both by the Exres community, as well as by the other agencies involved, to the position of CU administrator. It was possible to conclude, therefore, that the only Exres

administrator does understand the objectives and policies of the CU.

CONCLUSION: The indicators "employees," "administrators" and "policies" revealed a frightening reality about the PA's objectives: a lack of human resources. ROP EXRES does not have a single official. The EXRES has only one director. In turn, the administrator of the EXRES also does not have a team of satisfactory support, and has to share tasks with employees of ICMBio and count on the support of employees from this organization, including: research, internships, provision of temporary services, among others. The lack of human resources impedes the effective implementation of public policies intended for CUs and EXRES like that of ROP.

5.5 Do local communities (i7) support the goals of the CU?

Analysis of the 2014 ROP EXRES management plan concluded that the local community supports the objectives of the CU being studied. Verification of this information was made possible by finding, in the analyzed document, several passages, in which it is stated that the residents of the protected area proposed objectives. The community was able to propose the objectives, and to prepare, evaluate and discuss them by participating at different times in meetings organized and systematized for this purpose, namely, to build the CU's objectives with community participation. This occurred during various types of meetings: encounters, workshops and assemblies, the community was consulted on what the objectives related to environmental, social and economic aspects of ROP EXRES should be.

The study allowed for the above conclusion by identifying the following texts in the management plan:

a) on pages 9 and 10 it appears that preparation of the management plan was carried out through a split consultancy in stages, in which there was always participation of the extractivists;

b) On page 106 community support is again clear, with the definition of the objectives of the Management Agreement, through a participatory workshop held in 2012, analyzed in this paper in subsection 6.5 "**Common**" objectives for the "Management Agreement".

c) the 6 consultancies carried out between the years 2009 and 2013 demonstrate community support, since they were carried out with the help and participation of extractivists. The management plan talks about this on page 9, in which it relates to the subject using the terms

"participatory work." Later the text talks about a "participatory workshop" and continues inserting these indications throughout the entire production of the document;

d) it is also possible to identify this support on page 11, where it is written that the management plan has been prepared in a participatory manner to better develop its content. The fact that most showed community support was the occurrence of the participatory workshop in 2013, when a representative from each community was allowed to choose the goals they considered most relevant to the development of the reserve; it is worth mentioning that these representatives were chosen by extractivists themselves.

e) despite being information not found in the management plan, but rather in the report assessing PA management in the 2005/2006 and 2010 cycles applied in Brazil, it is worth noting: RAPPAM presents the following results regarding the support of local communities to objectives:

i) in sustainable use protected areas in general in Brazil - 2005-2006 66.8% of communities support PA objectives;

ii) in extractive reserves in general in Brazil - 2010 - 60.4% of communities support PA objectives.

Apart from the above discriminated passages, it is important to note that the participation of local communities in the preparation of the management plan is a right guaranteed by law no. 9985 from July 18, 2000, in Chapter VI, Article 27, paragraph 2 and by Normative Instruction No. 7/2017/GABIN/ICMBIO from December 21, 2017, in chapter I, Article 10.

Over the past few years, the importance of participation by traditional communities in CU management has been discussed, not only because they are the major beneficiaries of environmental conservation, but also because they know the harsh reality of those who live in a protected area. Thus, it is very important to listen to them and consider their opinions about these issues. A workshop is considered an educational space in which everyone involved has the opportunity to express their opinions, actively participating in the process of knowledge construction.

CONCLUSION: The "local communities" revealed through the analysis, satisfactory participation regarding support of the goals of sustainable CU. The support is shown by indication of keywords such as general assembly and participatory workshops in addition to several passages in the management plan on participatory construction of the residents of the CU and the

community being involved in preparing the Exres objectives.

5.6 Do the members of the CU's management board (i8) understand the objectives and policies of the CU?

The result of the study on the last issue of the "Objectives Module" from the RAPPAM method shows that members of the management board do indeed understand the objectives and policies of the CU in question. In view of the analysis methodology used against the Exres's management plan, it can be stated that board members do indeed comprehend the objectives and policies of ROP EXRES. This observation is due to the following findings about the analyses carried out:

a) from the reading of documents and consideration of legal basis, laws and other legislation that set forth rules on the composition of a CU's management board, as well as the functions of their constituent members. Among the main legal instruments used, the analysis consisted of:

- i) Federal Law No. 9985 from July 18, 2000 - institutionalizes SNUC;
- ii) Decree No. 4340 from August 22, 2002 - regulates the law of SNUC;
- iii) Ordinance/ICMBio No. 89 from November 22, 2006 - creates the deliberative council of ROP EXRES;
- iv) Ordinance/ICMBio No. 27 from February 17, 2012 published in the Official Gazette Journal of the Union (DOU) from February 22, 2012 - updated creation decree of the ROP EXRES board;
- v) the Internal Rules of the ROP EXRES Board. Note: All these legal bases studied were indicated by the management plan.

b) according to Decree No. 4340 from August 22, 2002 Chapter V, paragraphs 1 and 2, the board should be composed of representatives from various environmental agencies and non-governmental organizations with egregious scientific knowledge and experience in areas related to environmental protection. In compliance with the decree, the ROP EXRES council consists of representatives of various bodies, from ICMBio to the Federal Police. A complete list of council representatives is contained on page 118 of this text and on pages 103 and 104 of the management plan. The list is made up of representative bodies of important segments of society, both public and private. Analyses of the management plan, when presented with the information listed above, made it possible to conclude that the representatives have complete capacity to understand the objectives and policies of the PA;

c) the competency of the board members is also shown on page 103 of the CU's management plan, where a series of complex activities that are board responsibilities is listed, which, without knowledge of how public administration works, board members would not be able to carry them out. Just to get a sense of some of these activities, they involve evaluating the unit's budget and proposing guidelines for the integration of the relationship between Exres communities.

d) Another important piece of data is the fact that some agencies with representatives on the board, chose candidates using highly complex public exams, requiring knowledge in many areas of science.

e) in turn, another analysis, a secondary one, yet something that supports the findings in this part of the study was the consideration of the RAPPAM method's own graphics, applied in the 2005/2006 and 2010 cycles in ROP EXRES, which allowed by analogy to make a conclusion regarding the understanding of the board members regarding the Exres's goals. Analysis of the graphs found on pages 46 and 64 of the RAPPAM report from cycles 2005 to 2006 and 2010, and in this text on page 120, allowed for conclusions regarding the understanding of the members of the management council on the objectives and policies of ROP EXRES.

f) Finally, another indicator to corroborate the conclusion that the members of the management board understand the PA's objectives is the statement in the management plan that ICMBio itself, an institution considered to be the greatest authority on preservation of protected areas in Brazil, is the chairman of the board of ROP EXRES. Established by law 11,516 of August 28, 2007, ICMBio since its inception, has improved performance in CU protection. The legal document designed to regulate the establishment and operation of the management councils of PAs, Normative Instruction No. 7/2017/GABIN/ICMBIO of December 21, 2017, is authored this organization.

CONCLUSION: Confirmation of understanding of the CU's objectives by the members of the ROP EXRES Board, a result with the indicator "management board", was earned in accordance with the regulatory norms on the subject, which are incisive in confirming the skills comprising the aforementioned council. According to the list of members that make up the CU's management council studied, registered in the ROP EXRES management plan and the authority of the acronyms that name the institutions, and by reference to the skills of the board indicated by the legal norms governing the matter,

it was concluded that the management council understands the objectives and policies of the CU.

5.7 Epilogue

Finally, the methodology for identification of strategic objectives, broken down by the management plan, proved to be easy to use and understand: an election of the objectives considered of highest priority for the community, among those that were already in place as objectives of the Exres's plans, programs and projects, indicate the top voted as strategic objectives. However, the plan fails in the application of the method when it excludes the objective that occupies the 10th place in the ranking elected by the residents, the objective "sanitation", and includes in the Strategic Map of the Reserve three (3) other elected goals in positions lower than 10, specifically: "Training courses", "Brazil nut" and "Tourism", 11th, 12th and 16th respectively in rankings.

In addition to the above, the bottleneck steps used to reach the strategic objectives obey the following order: ranking goals, BSC method strategic objectives and the Strategic Map. In the structure of the ranking, four (4) objectives are excluded, including "Land tenure - consolidate land regularization of the Exres for full implementation of the management plan," objective discriminated on page 136. It turns out that the goal "Remedy the land situation" reappears as a strategic objective in the list of the BSC method, and therefore is part of the strategic Map.

The objectives of the management plan were harmed in the sense that there is great confusion about the design and effectiveness of its main objectives: the strategic ones. The strategic objectives are very important in a CU because they are considered of highest priority according to the community's main needs.

5.8 Suggestions

As a contribution to improve the development of objectives that permeate the Pas' Management Plans in any area of interest, this study makes three suggestions:

a) The inclusion of a greater number of objectives focused on the "sustainable development" as the main factor of development is recommended, especially when dealing with strategic objectives, in order to configure the objectives aimed at meeting the community's needs, as was found in just 11 instances of a total of 53 objectives present throughout the plan, namely:

I) Specific objectives (1 from the existing 5):
Ensure sustainable use of natural resources - p. 17;

II) General Purpose of the PSAS program (1 1):
Aim to promote environmental conservation, sustainable management of natural resources, value culture and improve the quality of life of the traditional population - p. 123;

III) Common objectives from the PSAS programs (one from the existing 4):

Natural Resources and Productive Chains Management Program

Objective: To promote environmental conservation and sustainable management of natural resources in the Rio Ouro Preto Exres- p. 128;

IV) Common Objectives of the PSAS subprograms (5 of 21 existing):

b.3 "Other Extractive Products" Subprogram

Objective: To improve the income of the Exres beneficiaries through the commercialization of sustainable extractive products - p. 129;

b.4 Wild Animal Management Subprogram

Objective: To sustainably and adequately manage species of wild fauna from the Exres that are causing damage to communities - p. 130;

b.6 Food Safety Subprogram - Agriculture

objective: To improve agricultural practices, increasing sustainability, productivity and add value to the products of the Exres - p. 131;

b.8 Timber Products Subprogram

objective: To improve the income of extractivists through the sustainable management of timber - p. 132;

b.9 Tourism Subprogram

objective: To involve stakeholders from Guajar Mirim in a sustainable ecotourism experience that strengthens the culture of forest peoples through the principles of solidarity, cooperation and care for the earth - p. 132;

V) Common Objectives from the Management Agreement (1 of 2 existing):

a) To ensure the self-sustainability of the EXRES by regulating the use of resources and behaviors to be followed by the locals - p. 107;

VI) Strategic Objectives (2 of 20 existing):

BSC method references: Internal Processes

Keyword: Do

15) Facilitate the Plan for Sustainable Forest Management (PMFS) - p. 140

17) Obtain administrative and financial self-sustainability (associations) - p. 140

b) The use of the questions from "Thematic Module 6 - Objectives" from the RAPPAM method is recommended as a reference, in the construction and improvement of management plan objectives in order to measure the quality of these objectives and in order to reach them.

c) It is recommended to update the 2014 ROP EXRES management plan objectives predicted after the year 2019, a readjustment in the presentation of the strategic objectives, more resolute content with only textual aim, taking care not to impair the management plan's objectivity and automatically the sustainable development of extractive reserves.

d) It is further recommended the introduction of the term "biodiversity" on a larger scale and more explicitly, in view of the importance of its significance for the community, for society, for ROP EXRES, for PAs in general, for the protection of nature and the environment as a whole.

REFERENCES

- [1] ABNT. Brazilian Association of Technical Standards. NBR 14724: Information and documentation: academic papers: presentation. Rio de Janeiro: ABNT 2011.
- [2] _____. ISO 10006: Quality management - Guidelines to quality in project management. Rio de Janeiro, 2000.
- [3] ANDRADE, Daniel Caixeta; PALMER, Ademar Ribeiro. natural capital, ecosystem services and economic system: towards a "economics of ecosystems." São Paulo: Discussion Paper 159, Institute of Economics of Unicamp, 2009.
- [4] _____. ecosystem services and their importance for the economic system and human well-being. Foz do Iguaçu (Paraná): Discussion Paper 155, Institute of Economics of Unicamp. 2009.
- [5] GARLIC, Cleber JR importance of biodiversity for human health: an ecological perspective. São Paulo: Advanced Studies (USP Form.), V. 26, p. 151-166, 2012.
- [6] ARAUJO, Rodrigo Rodrigues dos. Ecotourism, sustainable form of environmental tourism development. Monography. Rio de Janeiro: [sn], 2012.
- [7] ARRUDA, Rinaldo. "Traditional populations" and the protection of natural resources in protected areas. In: Environment & Society. Curitiba: [sn], 1997.
- [8] BARBIERI, Edison. Biodiversity: the variety of life on the planet. Sao Paulo: Fishing Institute, 2010. Available at:<http://www.pesca.agricultura.sp.gov.br/publicacoes/outros-texts-for-query>. Access: 27 November 2018.
- [9] BARBOSA, Jorge Luiz. Citizenship, territory and public policy. Rio de Janeiro: [sn], 2009. Available at:<http://of.org.br/categoria/acervo/articles/>. Access: 27 November 2018.
- [10] BARROS, Ligia Paes. Seminar marks the end of the Dialogue Project. Brasilia: [s. n], 2009. Available at:https://www.wwf.org.br/wwf_brasil/contato/contatos/. Access: 21 October 2011.
- [11] BORCHE, Maria Isabel Fonseca Alves da Silva. Access to land and social justiça in Rondônia. Porto Velho: [sn], 2016.
- [12] BUARQUE, Sidney Hartung. The invasion of the Amazon rainforest. São Paulo, Monitor Mercantil, 2013. Available at:<https://monitordigital.com.br/a-invasao-da-floresta-ama-zunica>. Accessed on 11 February 2019.
- [13] BRAZIL. management evaluation of protected areas: methods RAPPAM (2015) and SAMGE (2016). Brasilia: [sn], 2017.
- [14] _____. Good management practices for organic sustainable harvesting. Brasilia: [sn], 2012.
- [15] _____. Decree No. 4340 of August 22, 2002. Regulates articles of Law No. 9985 of July 18, 2000, which provides for the National System of Nature Conservation Units - SNUC, and other measures. Brasilia: [sn], 2002. Available at:http://www.planalto.gov.br/ccivil_03/decreto/2002/D4340.htm. Accessed on: February 17, 2019.
- [16] _____. Instruction No. 01 of 18 September 2007. Discipline Guidelines, Standards and Procedures for the Preparation of Participatory Management Plan of Federal Conservation Unit Categories of Extractive Reserve and Sustainable Development Reserve. Brasilia: [sn], 2007.
- [17] _____. Instruction No. 16 of August 4, 2011. It regulates, under the Instituto Chico Mendes, guidelines and administrative procedures for the approval of the Plan for Sustainable Forest Management (PMFS) Community for exploitation of timber resources within the extractive reserve, sustainable development reserve and national forest. Brasilia: [sn], 2011.
- [18] _____. **law n^o 9985 of 18 July 2000.** [online]. Establishing the National System of Conservation Units of Nature and other measures. Brasilia: 2000. Available at:http://www.planalto.gov.br/ccivil_03/LAWS/L9985.htm. Accessed on: December 6, 2018.
- [19] _____. **Law No. 12,651, of May 25, 2012.** It provides for the protection of native vegetation. Brasilia: [sn], 2012.
- [20] _____. **Law No. 13,465, of July 11, 2017.** It provides for the rural and urban land regularization, on the settlement of loans granted to agrarian reform settlers and the land regularization under the Legal Amazon. Brasilia: [sn], 2017.
- [21] _____. Ministry of the Environment. DEA will launch good practice in family farming. Brasilia: [sn], 2012. Available at:<http://www.icmbio.gov.br/educacaoambiental/highlights/48-dea-will-launch-good-practices-in-agriculture-familiar.html>. Access: 15 December 2018.
- [22] _____. _____. Brazilian Enterprise for Agricultural Research. Manual of good agricultural practices and HACCP. Brasilia, 2004. (Series Quality and Food Safety).
- [23] _____. _____. ICMBIO. Instruction No. 01 of 18 September 2007. [online] Brasilia, 2007. Available at:<http://www.icmbio.gov.br/portal/images/stories/what-are/in012007.pdf>. Accessed on: December 6, 2018.
- [24] _____. _____. Brazilian Institute of Environment and Renewable Natural Resources. methodological guide for

- the elaboration of the management plan of extractive reserves and sustainable development feds. Brasília: [sn], 2006.
- [25] _____. Ministry of the Environment. traditional peoples and communities: [sn], 2018. Available at:<http://www.mma.gov.br/desenvolvimento-rural/terras-ind%C3%ADgenas,-povos-and-community-tradicionais.html>. Access: 25 November 2018.
- [26] _____. _____. Secretary of Biodiversity and Forests. Convention on Biological Diversity, Brasília, 2000. (Biodiversity Series, 2).
- [27] _____. management plan for the extractive reserve of Rio Ouro Preto. GuajaráMirim: [sn], 2014.
- [28] _____. management plan for the federal extractive reserves the Cautário river. Porto Velho: [sn], 2017.
- [29] _____. Public policies for forest peoples. Brasília: [sn], 2013.
- [30] BRASÍLIA. sustainable management of native forests. Series Sustainable Property: Management for Low Carbon Agriculture Technical Document 5: Sustainable Management of Native Forests. Brasília: Publisher IABS, 2017.
- [31] _____. land tenure in protected areas: operations manuals Series. Brasília: [sn], 2014.
- [32] CABRAL, Roger B. Strategic management. In: Training Cycle in Managing for Results. Brasília. NEXUCs. Module 3. 2012.
- [33] CAETANO, Patricia Pereira; MELO, Maiara Gabrielle de Souza; BRAGA, Cybelle Frazão Costa. Payment for environmental services (PES) - analysis of concepts and regulatory framework. Joao Pessoa: [sn], 2016. Available at:<http://periodicals.IFPB.edu.br/index.php/begins/article/view/443>. Access: 27 November 2018.
- [34] Calixto, Bruno. In Rondônia, deforestation is a police matter. Journal Times, 2018. Available at:<https://epoca.globo.com/ciencia-e-meio-ambiente/noticia/2018/01/em-rondonia-desmatamento-e-caso-de-policia.html>. Accessed on: 24 April 2018.
- [35] CAMPOS, Marina Thereza; Higuchi, Francisco Gasparetto. technical environment and sustainable development series. The Amazon forest and its role in climate change. Manaus: [sn], 2009.
- [36] COSTA, Dahyana Siman Oak. permanent preservation areas or permanent conservation? Legal Bulletin Uberaba / MG, a. 5, at 232. Available at:<https://www.boletimjuridico.com/doctrine/article/1810/areas-preservacao-permanente-ou-conservacao-permanente>. Access: 8 March 2019.
- [37] COSTA, Vandr ea Pereira Da. Instruments for land regularization in app's. Santos: Journal of Civil Law, 2013.
- [38] CRAVEIRO, Isabelle Christine steps. Use of geotechnology in the detection of deforestation in the extractive reserve Cazumb a - Iracema in Acre. Rio Branco (AC): [sn], 2013.
- [39] DANTAS, Fernanda Gabriela Leal. regularization of traditional communities. Petrolina (Pernambuco): [Sn], 2015.
- [40] EMBRAPA. soil conservation practices and water. Para ba: [sn], 2012. Available at:<https://www.embrapa.br/busca-de-publicacoes/-/publicacao/928493/practices-conservation-of-the-ground-and-water>. Acessoem: September 14, 2018.
- [41] F ARIA, Helder Henrique; PIRES, Andrea Soares. Administration, management or management of protected areas? Sao Paulo: Environmental Forum Alta Paulista, v. 8, p. 43 to 59.2012.
- [42] FERREIRA, Bruno. Manual of good agricultural practices: conservation and management of pollinators for sustainable agriculture. Rio de Janeiro: [sn], 2015.
- [43] FERREIRA, Iremar Antonio. Lit torches in the woods. Rond onia: [sn], 2009.
- [44] FRANCO, Jos e Luiz de Andrade. The concept of biodiversity and history of conservation biology: the preservation of wilderness biodiversity conservation. S ao Paulo: History (Online) v. 32, p. 21-48, 2013.
- [45] FRANZON, Peter. Extractive Reserve in Rio Ouro Preto / RO: regional development agents or forest guardians? Rond onia: Presence Journal of Education, Culture and Environment, 2002.
- [46] FREITAS, Junior. Clonal coffee. Rond onia: [s. n], 2017. Available at: <https://g1.globo.com/ro/Guajar Mirim-region/news/project-cafe-clonal-comes-the-stage-the-conclusao-to-plant-to-30-thousand-mute-in-guajararo.ghtml>. Access: 10 September 2018.
- [47] Granha, JRDO; CAPRONI, Ana Lucy; Sampaio, Alan da Silva; Sampaio, Leo da Silva; BERBARA, Ricardo Luis Louro. biodiversity relationships of soil fauna in the soil of extractive reserve of Rio Preto-RO gold. Pocos de Caldas 2017. (Minas Gerais): [sn], 2017. Available at:<http://www.meioambientepocos.com/anal-2017/-previous-editions/>. Accessed on 20 March 2018.
- [48] GUIMARAES, Maria. Gears of forests. Sao Paulo. Pesquisa FAPESP, 2018. Available at: <http://revistapesquisa.fapesp.br/2018/02/15/asengrenagens-the-forest/>. Access on 11 February 2019.
- [49] Herrero, Thais. protected areas lack supervision and planning. Journal Times. Rio de Janeiro: [sn], 2015. Available at:<https://epoca.globo.com/column-and-blogs/blog-the-planet/amazon/news/2015/06/elis-araujo-units-of-conservation-lack-DEFIScalisation-and-planejamento.html>. Accessed on: 06 February 2019.
- [50] ICMBIO. Because the Chico Mendes Institute was created? Bras lia: [sn], 2013. Available at:<http://www.icmbio.gov.br/portal/perguntas-frequentes/158-porque-o-instituto-chico-mendes-foi-criado>. Accessed on 23 August 2017.
- [51] _____. D'Amico, Ana Rafaela, Lessons learned about social participation in the preparation of management plans of protected areas - teaching and learning in community planning of protected areas. Bras lia: [sn], 2013. Available at:<https://www.wwf.org.br/informacao/>

- library could /? 37343 / Social Participation-in-Elaboration-of-planes-of-management-of-the-Units-preserving. Access: 22 November 2018.
- [52] _____. Reflections on management councils of federal conservation units. Brasília: [sn], 2013.
- [53] Infopédia; Dictionaries Porto Editora. Plan. Port: Porto Editora, 2003-2019. Available in:<https://www.infopedia.pt/dicionarios/lingua-portuguesa/pl> years. Access on 10 February 2019.
- [54] INPE. Deforestation in protected areas. São Paulo: [sn], 2018. Available at:<http://www.dpi.inpe.br/prodesdigital/prodesuc.php>. Access on: 09 August 2018.
- [55] _____. INPE EXPANDS MONITORING OF THE AMAZON WITH DATA FROM THE NEW GENERATION OF ENVIRONMENTAL SATELLITES. SAO PAULO: [SN], 2018. AVAILABLE AT:http://www.inpe.br/news/noticia.php?cod_noticia=4829. Acesso em: 09 August 2018.
- [56] INPE. annual rates of deforestation in the Brazilian Amazon (AMZ). São Paulo: [sn], 2018. Available at:<http://www.obt.inpe.br/prodes/dashboard/prodes-rates.html>. Accessed on: 09 August 2018.
- [57] Environmental Institute of Paraná. The importance of wildlife. Parana [s. n], 2018. Available at:http://www.redepro_fauna.pr.gov.br/modules/conteudo/conteudo.php?conteudo=160. Accessed on 11 February 2019.
- [58] JEROZOLIMSK, Ricardo. Implementation of strategic planning in the Arolos National Marine Park. Bahia: [sn], 2013.
- [59] Kanindé: If Rondônia: over 500 thousand hectares of forest protected under attack. Rondônia: [sn], 2018. Available at:<http://www.kaninde.org.br/mais-de-500-mil-hectares-de-floresta-protegida-sob-ataque/>. Access on: 10 September 2018.
- [60] KRAEMER, Elisabeth Maria Pereira. Ecological tourism and sustainability. Santa Catarina [sn], 2005. Available at:<https://www.gestiopolis.com/the-tourist-ecological-and-sustainability/>. Accessed on 11 February 2019.
- [61] KURY, Karla Aguiar. land tenure in protected areas: the case of Desengano State Park / RJ. Fields of Goytazes: [sn], 2009.
- [62] LONG, Mariana Hortelani Carneseca; RODRIGUES, Ricardo Ribeiro. ecosystem services analysis in the environmental impact assessment: proposal and application for a mining enterprise. Sao Paulo: Development and Environment (UFPR), v. 43, p. 103-125, 2017.
- [63] MADRIGAL, Alexis. The exercise of citizenship in the development of society. Jus Navigandi magazine. Teresina: [sn]2016. Available in:<https://jus.com.br/articles/48124>. Accessed on 23 May 2018.
- [64] Martins, J. Casimir; FERNANDES, Rui. soil degradation processes-measures of prevention. Lisbon (Portugal): [sn], 2017.
- [65] Meneguzzo, Isonel Sandino; CHAICOUSKI, Adeline. Reflections on the concepts of environmental degradation, environmental impact and nature conservation. Geography, Londrina, Londrina (Paraná): v. 19, no. 1, p. 181-185, 2010.
- [66] Menezes, M. LC Project Management. São Paulo: Atlas, 2001
- [67] MICHELIS; Brazilian Dictionary of the Portuguese Language. Plan. [S. l]. Improvements not paginated. Online. Available in:<https://michaelis.uol.com.br/moderno-portugues/search/Portuguese-Brazilian/plan/>. Accessed on 11 February 2019.
- [68] Ministry of the Environment. Management Councils. Brazil [sn], 2019. Available at:<http://www.mma.gov.br/areas-protegidas/unidades-de-conservacao/conselhos-gestores.html>. Access: 17 February 2019.
- [69] MORALES, Maria Aparecida Marin; ROBERTO, Matheus Mantuanelli; ANDELISA, Franceschi of; ANGELIS, Darlene Attili. Importance of water for life and guarantee maintaining its quality. São Paulo: [sn], 2018. Available at:<http://www.mpf.mp.br/performance-thematic/CCR4/data-of-performance/projects/Quality-of-the-water/bulletin-the-waters/articles-scientific/importance-of-water-for-a-life-and-guarantee-of-maintenance-your-quality/view>. Access: 26 November 2018.
- [70] MORET, Artur de Souza. vegetable oil as fuel for electricity in small clusters of Rondônia as a way of generating income. GPERS / UNITE. Rondônia: [sn], 2005.
- [71] UN - FAO - Organization of the united nations food and agriculture. Good agricultural practices. Brazil [sn], 2007. Available at:<http://www.ceasa.gov.br/data/text/pub45.pdf>. Accessed on 11 February 2019.
- [72] Parron, Lucilia Maria; GARCIA, Junior Ruiz; OLIVEIRA, Edilson Batista; BROWN, George Gardner Brown; PRADO, Rachel Bady. environmental services in agricultural and forestry systems of the Atlantic Forest. Brasília: Embrapa, 2015.
- [73] PELLIZARO, Patricia Costa; HARDT. Letícia Peret Antunes; HARDT, Carlos; Hardt, Marlos; SEHLI, Dyala Asséf. Management and management of protected natural areas: international context. Sao Paulo: Environment & Society, 2015.
- [74] PEREIRA, Barbara Elisa; Diegues, Antonio Carlos. The knowledge of traditional populations as a possibility for nature conservation: a reflection on the perspective of ethnoconservation. Paraná: Editora UFPR, n. 22, p. 37-50, jul./dez. 2010.
- [75] Pereira, Karina Such Krugerr; MORAIS, Joselânio Ferreira. GIS techniques applied to environmental problems affecting the river Iaco within the municipality of Sena Madureira AC-limit. Santa Maria: Electronic Journal of Management, Education and Environmental Technology - REGET, 2014.
- [76] PIONTEKOWSKI, Valderli Jorge; Matricardi, Eraldo Aparecido Trondoli; Pedlowski, Marcos Antonio; FERNANDES, Luis Claudio. deforestation assessment in

- the state of Rondônia between 2001 and 2011. Brasília: Forest and Environment, 2014.
- [77] PIOVESAN, Juliana Costa; Hataya, Rafael; PINTO-MILK, Clarissa Machado; Rigueira, Dary Moreira Gonçalves; Neto, Eduardo Mariano. ecological processes and landscape scale as guidelines for ecological restoration projects. Bahia: Magazine peccary, 2013.
- [78] RAMOS, Caroline. Use of GIS techniques for optimizing patterns on linear projects. Porto Alegre: [sn], 2009.
- [79] REIS, Émilien Vilas Boas; OLIVEIRA, Márcio Louis. Urban and rural land tenure: the need for theoretical frameworks and different public policies. In: Journal of Public Policy (online), v. 7, No. 2, 2017.
- [80] Ribeiro, Beatriz; VERÍSSIMO, Wojciech; PEREIRA, Katya. The advance of deforestation on protected areas in Rondônia. Belem (Para): [sn], 2005. Available at:<https://imazon.org.br/publicacoes/o-avanco-do-des-matamento-on-the-areas-protected-in-rondonia/>. Access: September 14, 2018.
- [81] RONDÔNIA. Prevention plan, control and sustainable alternatives to deforestation in Rondônia. Porto Velho: [sn], 2009. Available at:<http://www.mma.gov.br/informma/item/843-rond%C3%B4nia.html>. Access: 28 November 2018.
- [82] RUEDA, Rafael Pinzón. extractive reserves. IUCN program for the conservation of forests. Brasília: [sn], 1995. Available at:<https://www.iucn.org/es/content/TAS-extrati-vis-reservations>. Access: 28 November 2018.
- [83] SANTOS, Fabiana Bezerra Neves; MORET, Artur de Souza. Environmental awareness in RESEX Rio Ouro Preto and the evidence that the forest standing is the basis for local development. Rondônia: V ENNANPAS, 2010.
- [84] SAHDO, Rosana Martiniano. Management by competence: profile and administrator's view of the state of Amazonas protected areas. Manaus [sn], 2018.
- [85] SANTOS, Rozely. The historical context of the conceptual definition of ecosystem services. Adapted from Lima, William F. São Paulo: [sn], 2012.
- [86] IUCN. conservación Center de la IUCN, Switzerland: [Sn], 2017. Available at: [https://www.iucn.org/es/acerca-de-la-IUCN/center-of-conservaci%C3%B3n-de-la-IUCN/](https://www.iucn.org/es/acerca-de-la-IUCN/center-of-conservaci%C3%B3n-de-la-IUCN). access: Aug 31, 2017.
- [87] VALIANTE, Jose Otavio; SIENA, Osmar. Sustainable production in extractive reserves. White River: Brazilian Society of Economics, Business and Rural Sociology, 2008.
- [88] VARGAS, Ricardo V. Project management in micro and small businesses. Podcast of the week 15 October 2007. Available at:<http://www.ricardovargas.com/pt/podcasts/smallcompanies/>. Accessed on: 05 June 2014. E-book.
- [89] _____. Project management. Establishing competitive advantages / Ricardo Vargas; foreword by Harold R. Reeve - 7. ed. Rio de Janeiro: Brasport, 2009.
- [90] VIANA, Guilherme Ferreira. EMBRAPA and partners working in sustainable projects for Amazon reserve areas. Rondônia: [sn], 2004. Available at:<https://www.embrapa.br/busca-de-noticias/-/noticia/17968113/embrapaeparceiros-atuam-em-projetos-sustentaveis-em-areas-da-amazonia>. Access: 15 October 2018.
- [91] WAWZYNIAK, John Valentin. Rondonia - Ouro Preto Extractive Reserve Rio: changes in forms of appropriation of nature and survival strategies. In: The forest destination: extractive reserves and sustainable development in the Amazon. Rio de Janeiro: [sn], 1994.
- [92] WHATELY, Marussia; Hercowitz, Marcelo. Environmental services: to know, value and care: support for the protection of water sources of. São Paulo: [sn], 2008.
- [93] WWF-BRAZIL. Management effectiveness of federal conservation units: comparative evaluation of applications RAPPAM method in federal conservation units in cycles 2005-06 and 2010. Brasília: [sn] 2012.
- [94] _____. RAPPAM evaluates effectiveness of MS and MT UCs. Brasília: [sn], 2017. Note published on 10 May 2017. Available at:<https://www.wwf.org.br/?57802>. Access in: 4 February 2018.
- [95] Zapparoli, Irene Domenes; CAMARA, Marcia Regina Gabardo. forest management plan on a property of Mato Grosso: the theory in practice. Rio Branco (Acre): [sn], 2008. In: XLVI Congress of the Brazilian Society of Rural Economics and Sociology - SOBER, 2008.

References In Portuguese

- [1] ABNT. Associação Brasileira de Normas Técnicas. NBR 14724: **Informação e documentação: trabalhos acadêmicos: apresentação**. Rio de Janeiro: ABNT, 2011.
- [2] _____. ISO 10006: **Gestão da qualidade - diretrizes para a qualidade no gerenciamento de projetos**. Rio de Janeiro, 2000.
- [3] ANDRADE, Daniel Caixeta; ROMEIRO, Ademar Ribeiro. **Capital natural, serviços ecossistêmicos e sistema econômico: rumo a uma "economia dos ecossistemas"**. São Paulo: Texto para Discussão 159, Instituto de Economia da UNICAMP, 2009.
- [4] _____. **Serviços ecossistêmicos e sua importância para o sistema econômico e o bem-estar humano**. Foz do Iguaçu (Paraná): Texto para Discussão 155, Instituto de Economia da UNICAMP, 2009.
- [5] ALHO, Cleber J. R. Importância da biodiversidade para a saúde humana: uma perspectiva ecológica. São Paulo: **Estudos Avançados** (USP. Impresso), v. 26, p. 151-166, 2012.
- [6] ARAÚJO, Rodrigo Rodrigues dos. **Ecoturismo, uma forma sustentável de desenvolvimento turístico ambiental**. Monografia. Rio de Janeiro: [s. n.], 2012.
- [7] ARRUDA, Rinaldo. "Populações tradicionais" e a proteção dos recursos naturais em unidades de conservação. In: **Ambiente & Sociedade**. Curitiba: [s. n.], 1997.
- [8] BARBIERI, Edison. **Biodiversidade: a variedade de vida no planeta**. São Paulo: Instituto de Pesca, 2010. Disponível em: <http://www.pesca.agricultura.sp.gov.br/publicacoes/ou-tros-textos-para-consulta>. Acesso em: 27 nov. 2018.

- [9] BARBOSA, Jorge Luiz. **Cidadania, território e políticas públicas**. Rio de Janeiro: [s. n.], 2009. Disponível em: <http://of.org.br/categoria/acervo/artigos/>. Acesso em: 27 nov. 2018.
- [10] BARROS, Ligia Paes de. Seminário marca fim do Projeto Diálogos. Brasília: [s. n.], 2009. Disponível em: https://www.wwf.org.br/wwf_brasil/contato/contatos/. Acesso em: 21 out. 2011.
- [11] BORCHE, Maria Isabel Alves Fonseca da Silva. **O acesso à terra e justiça social em Rondônia**. Porto Velho: [s. n.], 2016.
- [12] BUARQUE, Sidney Hartung. **A invasão da floresta Amazônica**. São Paulo, Monitor Mercantil, 2013. Disponível em: <https://monitordigital.com.br/a-invaso-da-floresta-amazunica>. Acesso em: 11 fev. 2019.
- [13] BRASIL. **Avaliação da gestão das unidades de conservação: métodos RAPPAM (2015) e SAMGE (2016)**. Brasília: [s. n.], 2017.
- [14] _____. **Boas práticas de manejo para o extrativismo sustentável orgânico**. Brasília: [s. n.], 2012.
- [15] _____. **Decreto nº 4.340 de 22 de agosto de 2002**. Regulamenta artigos da Lei nº 9.985 de 18 de julho de 2000, que dispõe sobre o Sistema Nacional de Unidades de Conservação da Natureza – SNUC, e dá outras providências. Brasília: [s. n.], 2002. Disponível em: http://www.planalto.gov.br/ccivil_03/decreto/2002/D4340.htm. Acesso em: 17 fev 2019.
- [16] _____. **Instrução Normativa nº 01 de 18 de setembro de 2007**. Disciplina as Diretrizes, Normas e Procedimentos para a Elaboração de Plano de Manejo Participativo de Unidade de Conservação Federal das Categorias Reserva Extrativista e Reserva de Desenvolvimento Sustentável. Brasília: [s. n.], 2007.
- [17] _____. **Instrução Normativa nº 16 de 4 de agosto de 2011**. Regula, no âmbito do Instituto Chico Mendes, as diretrizes e os procedimentos administrativos para a aprovação do Plano de Manejo Florestal Sustentável (PMFS) comunitário para exploração de recursos madeireiros no interior da reserva extrativista, reserva de desenvolvimento sustentável e floresta nacional. Brasília: [s. n.], 2011.
- [18] _____. **Lei nº 9.985, de 18 de julho de 2000. [on-line]**. Institui o Sistema Nacional de Unidades de Conservação da Natureza e dá outras providências. Brasília: 2000. Disponível em: http://www.planalto.gov.br/ccivil_03/LEIS/L9985.htm. Acesso em: 06 dez 2018.
- [19] _____. **Lei nº 12.651, de 25 de maio de 2012**. Dispõe sobre a proteção da vegetação nativa. Brasília: [s. n.], 2012.
- [20] _____. **Lei nº 13.465, de 11 de julho de 2017**. Dispõe sobre a regularização fundiária rural e urbana, sobre a liquidação de créditos concedidos aos assentados da reforma agrária e sobre a regularização fundiária no âmbito da Amazônia Legal. Brasília: [s. n.], 2017.
- [21] _____. Ministério do Meio Ambiente. **DEA lançará boas práticas na agricultura familiar**. Brasília: [s. n.], 2012. Disponível em: <http://www.icmbio.gov.br/educacao> ambiental/destaques/48-dea-lancara-boas-praticas-na-agricultura-familiar.html. Acesso em: 15 dez. 2018.
- [22] _____. _____. Empresa Brasileira de Pesquisa Agropecuária. **Manual de boas práticas agrícolas e APPCC**. Brasília, 2004. (Série Qualidade e Segurança dos Alimentos).
- [23] _____. _____. ICMBIO. **Instrução Normativa nº 01 de 18 de setembro de 2007**. [on-line] Brasília, 2007. Disponível em: <http://www.icmbio.gov.br/portal/images/stories/o-que-somos/in012007.pdf>. Acesso em: 06 dez 2018.
- [24] _____. _____. Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais renováveis. **Roteiro metodológico para elaboração do plano de manejo das reservas extrativistas e de desenvolvimento sustentável federais**. Brasília: [s. n.], 2006.
- [25] _____. Ministério do Meio Ambiente. **Povos e comunidades tradicionais**: [s. n.], 2018. Disponível em: <http://www.mma.gov.br/developmento-rural/terras-ind%3%ADgenas,-povos-e-comunidades-tradicionais.html>. Acesso em: 25 nov. 2018.
- [26] _____. _____. Secretaria de Biodiversidade e Florestas. **Convenção sobre diversidade biológica**, Brasília, 2000. (Série Biodiversidade, 2).
- [27] _____. **Plano de manejo da reserva extrativista do Rio Ouro Preto**. Guajará-Mirim: [s. n.], 2014.
- [28] _____. **Plano de manejo da reserva extrativista federal do rio Cautário**. Porto Velho: [s. n.], 2017.
- [29] _____. **Políticas públicas para os povos da floresta**. Brasília: [s. n.], 2013.
- [30] BRASÍLIA. **Manejo sustentável de florestas nativas**. Série Propriedade Sustentável: Gestão para Agricultura de Baixo Carbono: Documento Técnico 5: Manejo Sustentável de Florestas Nativas. Brasília: Editora IABS, 2017.
- [31] _____. **Regularização fundiária em unidades de conservação: Série manuais de atuação**. Brasília: [s. n.], 2014.
- [32] CABRAL, Rogério B. Gestão estratégica. *In: Ciclo de Formação em Gestão para Resultados*. Brasília. NEXUCs. Módulo 3. 2012.
- [33] CAETANO, Patrícia Pereira; MELO, Maiara Gabrielle de Souza; BRAGA, Cybelle Frazão Costa. **Pagamento por serviços ambientais (PSA) – análise de conceitos e marco regulatório**. João Pessoa: [s. n.], 2016. Disponível em: <http://periodicos. Ifpb .edu.br/index.php/principia/article/view/443>. Acesso em: 27 nov. 2018.
- [34] CALIXTO, Bruno. **Em Rondônia, desmatamento é caso de polícia**. Revista Época, 2018. Disponível em: <https://epoca.globo.com/ciencia-e-meio-ambiente/noticia/2018/01/em-rondonia-desmatamento-e-caso-de-policia.html>. Acesso em: 24 abr. 2018.
- [35] CAMPOS, Marina Thereza; HIGUCHI, Francisco Gasparetto. Série técnica meio ambiente e desenvolvimento sustentável. **A floresta Amazônica e seu papel nas mudanças climáticas**. Manaus: [s. n.], 2009.

- [36] COSTA, Dahyana Siman Carvalho da. **Áreas de preservação permanente ou de conservação permanente?** Boletim Jurídico, Uberaba/MG, a. 5, n° 232. Disponível em: <https://www.boletimjuridico.com.br/doutrina/artigo/1810/areas-preservacao-permanente-ou-conservacao-permanente>. Acesso em: 8 mar. 2019.
- [37] COSTA, Vandréa Pereira Da. **Instrumentos para regularização fundiária em app's.** Santos: Revista Brasileira de Direito Civil, 2013.
- [38] CRAVEIRO, Isabele Cristine Passos. **Uso de geotecnologias na detecção do desmatamento na reserva extrativista Cazumbá – Iracema no estado do Acre.** Rio Branco (AC): [s. n.], 2013.
- [39] DANTAS, Fernanda Gabriela Leal. **Regularização fundiária das comunidades tradicionais.** Petrolina (Pernambuco): [s. n.], 2015.
- [40] EMBRAPA. **Práticas de conservação de solo e água.** Paraíba: [s. n.], 2012. Disponível em: <https://www.embrapa.br/busca-de-publicacoes/-/publicacao/928493/praticas-de-conservacao-de-solo-e-agua>. Acesso em: 14 set 2018.
- [41] FARIA, Helder Henrique de; PIRES, Andréa Soares. **Administração, manejo ou gestão de unidades de conservação?** São Paulo: **Fórum ambiental de Alta Paulista**, v. 8, p. 43-59, 2012.
- [42] FERREIRA, Bruno. **Manual de boas práticas agrícolas: conservação e manejo de polinizadores para uma agricultura sustentável.** Rio de Janeiro: [s. n.], 2015.
- [43] FERREIRA, Iremar Antonio. **Fachos acesos na mata.** Rondônia: [s. n.], 2009.
- [44] FRANCO, José Luiz de Andrade. **O conceito de biodiversidade e a história da biologia da conservação: da preservação da wilderness à conservação da biodiversidade.** São Paulo: **História** (Online), v. 32, p. 21-48, 2013.
- [45] FRANZON, Pedro. **Extrativistas na Reserva Rio Ouro Preto/RO: agentes do desenvolvimento regional ou guardiões da floresta?** Rondônia: **Presença Revista de Educação, Cultura e Meio Ambiente**, 2002.
- [46] FREITAS, Júnior. **Café clonal.** Rondônia: [s. n.], 2017. Disponível em: <https://g1.globo.com/ro/guajara-mirim-regiao/noticia/projeto-cafe-clonal-chega-na-fase-conclusao-para-plantio-de-30-mil-mudas-em-guajara-ro.ghtml>. Acesso em: 10 set. 2018.
- [47] GRANHA, J. R. D.O.; CAPRONI, Ana Lucy; SAMPAIO, Alan da Silva; SAMPAIO, Léo da Silva; BERBARA, Ricardo Luis Louro. **Relações de biodiversidade da fauna edáfica no solo da reserva extrativista do Rio Ouro Preto-RO.** Poços de Caldas 2017. (Minas Gerais): [s. n.], 2017. Disponível em: <http://www.meioambientepocos.com.br/anais-2017/edicoes-anteriores/>. Acesso em: 20 mar. 2018.
- [48] GUIMARÃES, Maria. **As Engrenagens das florestas.** São Paulo. **Revista Pesquisa FAPESP**, 2018. Disponível em: <http://revistapesquisa.fapesp.br/2018/02/15/as-engrenagens-da-floresta/>. Acesso em: 11 fev. 2019.
- [49] HERRERO, Thaís. **Unidades de conservação carecem de fiscalização e planejamento.** Revista Época. Rio de Janeiro: [s. n.], 2015. Disponível em: <https://epoca.globo.com/colunas-e-blogs/blog-do-planeta/amazonia/noticia/2015/06/elis-araujo-unidades-de-conservacao-carecem-defiscalizacao-e-planejamento.html>. Acesso em: 06 fev. 2019.
- [50] ICMBIO. **Porque o Instituto Chico Mendes foi criado?** Brasília: [s. n.], 2013. Disponível em: <http://www.icmbio.gov.br/portal/perguntas-frequentes/158-porque-o-instituto-chico-mendes-foi-criado>. Acesso em: 23 ago. 2017.
- [51] _____. D'Amico, Ana Rafaela, **Lições aprendidas sobre participação social na elaboração de planos de manejo de unidades de conservação** - comunidade de ensino e aprendizagem em planejamento de unidades de conservação. Brasília: [s. n.], 2013. Disponível em: <https://www.wwf.org.br/informacoes/biblioteca/?37343/Participao-Social-na-Elaborao-de-Planos-de-Manejo-de-Unidades-de-Conservao>. Acesso em: 22 nov. 2018.
- [52] _____. **Reflexões sobre conselhos gestores de unidades de conservação federais.** Brasília: [s. n.], 2013.
- [53] INFOPEDIA; Dicionários Porto Editora. **Plano.** Porto: Porto Editora, 2003-2019. Disponível em: <https://www.infopedia.pt/dicionarios/lingua-portuguesa/plano>. Acesso em: 10 fev. 2019.
- [54] INPE. **Desflorestamentos nas unidades de conservação.** São Paulo: [s. n.], 2018. Disponível em: <http://www.dpi.inpe.br/prodesdigital/prodesuc.php>. Acesso em: 09 ago. 2018.
- [55] _____. **INPE amplia monitoramento da Amazônia com dados da nova geração de satélites ambientais.** São Paulo: [s. n.], 2018. Disponível em: http://www.inpe.br/noticias/noticia.php?cod_noticia=4829. Acesso em: 09 ago. 2018.
- [56] INPE. **Taxas anuais de desmatamento na Amazônia Legal Brasileira (AMZ).** São Paulo: [s. n.], 2018. Disponível em: <http://www.obt.inpe.br/prodes/dashboard/prodes-rates.html>. Acesso em: 09 ago. 2018.
- [57] Instituto Ambiental do Paraná. **A importância da fauna.** Paraná [s. n.], 2018. Disponível em: <http://www.redeprofauna.pr.gov.br/modules/conteudo/conteudo.php?conteudo=160>. Acesso em: 11 fev. 2019.
- [58] JEROZOLIMSK, Ricardo. **Implementação do planejamento estratégico no Parque Nacional Marinho dos Abrolhos.** Bahia: [s. n.], 2013.
- [59] KANINDÉ: **Caso Rondônia: mais de 500 mil hectares de floresta protegida sob ataque.** Rondônia: [s. n.], 2018. Disponível em: <http://www.kaninde.org.br/mais-de-500-mil-hectares-de-floresta-protegida-sob-ataque/>. Acesso em: 10 set. 2018.
- [60] KRAEMER, Maria Elisabeth Pereira. **O turismo ecológico e a sustentabilidade.** Santa Catarina [s. n.], 2005. Disponível em: <https://www.gestiopolis.com/o-turismo-ecologico-e-a-sustentabilidade/>. Acesso em: 11 fev. 2019.
- [61] KURY, Karla Aguiar. **Regularização fundiária em unidades de conservação: o caso do Parque Estadual do Desengano/RJ.** Campos dos Goytacazes: [s. n.], 2009.

- [62] LONGO, Mariana Hortelani Carneseca; RODRIGUES, Ricardo Ribeiro. Análise de serviços ecossistêmicos na avaliação de impacto ambiental: proposta e aplicação em um empreendimento minerário. São Paulo: **Desenvolvimento e Meio Ambiente (UFPR)**, v. 43, p. 103-125, 2017.
- [63] MADRIGAL, Alexis. O exercício da cidadania no desenvolvimento da sociedade. **Revista Jus Navigandi**. Teresina: [s. n.], 2016. Disponível em: <https://jus.com.br/artigos/48124>. Acesso em: 23 mai. 2018.
- [64] MARTINS, J. Casimiro; FERNANDES, Rui. **Processos de degradação do solo –medidas de prevenção**. Lisboa (Portugal): [s. n.], 2017.
- [65] MENEGUZZO, Isonel Sandino; CHAICOUSKI, Adeline. Reflexões acerca dos conceitos de degradação ambiental, impacto ambiental e conservação da Natureza. **Geografia, Londrina**, Londrina (Paraná): v. 19, n. 1, p. 181-185, 2010.
- [66] MENEZES, L. C. de M. **Gestão de projetos**. São Paulo: Atlas, 2001
- [67] MICHELIS; Dicionário Brasileiro da Língua Portuguesa. **Plano**. [S. l.]: Melhoramentos, não paginado. *Online*. Disponível em: <https://michaelis.uol.com.br/moderno-portugues/busca/portugues-brasileiro/plano/>. Acesso em: 11 fev. 2019.
- [68] Ministério do Meio Ambiente. **Conselhos Gestores**. Brasil [s. n.], 2019. Disponível em: <http://www.mma.gov.br/areas-protegidas/unidades-de-conservacao/conselhos-gestores.html>. Acesso em: 17 fev. 2019.
- [69] MORALES, Maria Aparecida Marin; ROBERTO, Matheus Mantuanelli; ANDELISA, Franceschi de; ANGELIS, Darlene Attili. **Importância da água para a vida e garantia de manutenção da sua qualidade**. São Paulo: [s. n.], 2018. Disponível em: <http://www.mpf.mp.br/atuuacao-tematica/ccr4/dados-da-atuuacao/projetos/qualidade-da-agua/boletim-das-aguas/artigos-cientificos/importancia-da-agua-para-a-vida-e-garantia-de-manutencao-da-sua-qualidade/view>. Acesso em: 26 nov. 2018.
- [70] MORET, Artur de Souza. **Óleo vegetal como combustível para energia elétrica em pequenos aglomerados de Rondônia como forma de geração de renda**. GPERS/UNIR. Rondônia: [s. n.], 2005.
- [71] ONU - FAO – Organização das nações unidas para a alimentação e agricultura. **Boas práticas agrícolas**. Brasil [s. n.], 2007. Disponível em: <http://www.ceasa.gov.br/dados/publicacao/pub45.pdf>. Acesso em: 11 fev. 2019.
- [72] PARRON, Lucília Maria; GARCIA, Junior Ruiz; OLIVEIRA, Edilson Batista; BROWN, George Gardner Brown; PRADO, Rachel Bardy. **Serviços ambientais em sistemas agrícolas e florestais do bioma Mata Atlântica**. Brasília: Embrapa, 2015.
- [73] PELLIZARO, Patrícia Costa; HARDT, Letícia Peret Antunes; HARDT, Carlos; HARDT, Marlos; SEHLI, Dyala Assef. **Gestão e manejo de áreas naturais protegidas: contexto internacional**. São Paulo: **Ambiente & Sociedade**, 2015.
- [74] PEREIRA, Bárbara Elisa; DIEGUES, Antonio Carlos. **Conhecimento de populações tradicionais como possibilidade de conservação da natureza: uma reflexão sobre a perspectiva da etnoconservação**. Paraná: Editora UFPR, n. 22, p. 37-50, jul./dez. 2010.
- [75] PEREIRA, Tais Karina Krugerr; MORAIS, Joselânio Ferreira de. Técnicas de geoprocessamento aplicadas aos problemas ambientais que afetam o rio Iaco dentro do limite do município de Sena Madureira-AC. Santa Maria: **Revista Eletrônica em Gestão, Educação e Tecnologia Ambiental - REGET**, 2014.
- [76] PIONTEKOWSKI, Valderli Jorge; MATRICARDI, Eraldo Aparecido Trondoli; PEDLOWSKI, Marcos Antonio; FERNANDES, Luis Claudio. **Avaliação do desmatamento no estado de Rondônia entre 2001 e 2011**. Brasília: Floresta e Ambiente, 2014.
- [77] PIOVESAN, Juliana Costa; HATAYA, Rafael; PINTO-LEITE, Clarissa Machado; RIGUEIRA, Dary Moreira Gonçalves; NETO, Eduardo Mariano. Processos ecológicos e a escala da paisagem como diretrizes para projetos de restauração ecológica. Bahia: **Revista Caititu**, 2013.
- [78] RAMOS, Caroline. **Utilização de técnicas de geoprocessamento para otimização de traçados em empreendimentos lineares**. Porto Alegre: [s. n.], 2009.
- [79] REIS, Émilien Vilas Boas; OLIVEIRA, Márcio Luís de. A regularização fundiária urbana e rural: necessidade de marcos teóricos e de políticas públicas distintos. In: **Revista Brasileira de Políticas Públicas** (online), v. 7, nº 2, 2017.
- [80] RIBEIRO, Beatriz; VERÍSSIMO, Adalberto; PEREIRA, Kátia. **O avanço do desmatamento sobre as áreas protegidas em Rondônia**. Belém (Pará): [s. n.], 2005. Disponível em: <https://imazon.org.br/publicacoes/o-avanco-do-des-matamento-sobre-as-areas-protegidas-em-rondonia/>. Acesso em: 14 set 2018.
- [81] RONDÔNIA. **Plano de prevenção, controle e alternativas sustentáveis ao desmatamento em Rondônia**. Porto Velho: [s. n.], 2009. Disponível em: <http://www.mma.gov.br/informma/item/843-rond%C3%B4nia.html>. Acesso em: 28 nov. 2018.
- [82] RUEDA, Rafael Pinzón. **Reservas extrativistas**. UICN programa para a conservação das florestas. Brasília: [s. n.], 1995. Disponível em: <https://www.iucn.org/es/content/reservas-extrativistas>. Acesso em: 28 nov. 2018.
- [83] SANTOS, Fabiana Bezerra Neves; MORET, Artur de Souza. A percepção ambiental na RESEX do Rio Ouro Preto e os indícios de que a floresta em pé é a base para o desenvolvimento local. Rondônia: **V ENNANPAS**, 2010.
- [84] SAHDO, Rosana Martiniano. **Gestão por competência: perfil e visão do administrador das unidades de conservação do estado do Amazonas**. Manaus [s. n.], 2018.

- [85] SANTOS, Rozely. **O contexto histórico da definição conceitual de serviços ecossistêmicos**. Adaptado de Lima, Guilherme F. São Paulo: [s. n.], 2012.
- [86] UICN. Centro de conservación de la UICN, Suíça: [S. n.], 2017. Disponível em: <https://www.iucn.org>. centro de conservación de la uicn. suíça: [s. n.], 2017. disponível em: [https://www.iucn.org/es/acerca-de-la-uicn/centro-de-conse rvaci%c3%b3n-de-la-uicn](https://www.iucn.org/es/acerca-de-la-uicn/centro-de-conse-rvaci%c3%b3n-de-la-uicn). acesso em: 31 ago. 2017.
- [87] VALIANTE, José Otávio; SIENA, Osmar. Produção sustentável em reservas extrativistas. Rio Branco: **Sociedade Brasileira de Economia, Administração e Sociologia Rural**, 2008.
- [88] VARGAS, Ricardo V. **Gerenciamento de projetos em micro e pequenas empresas**. Podcast da semana: 15 out. 2007. Disponível em: <http://www.ricardovargas.com/pt/podcasts/smallcompanies/>. Acesso em: 05 jun. 2014. *E-book*.
- [89] _____. **Gerenciamento de projetos**. Estabelecendo diferenciais competitivos/ Ricardo Viana Vargas; prefácio de Reeve Harold R. – 7. ed. Rio de Janeiro: Brasport, 2009.
- [90] VIANA, Guilherme Ferreira. EMBRAPA e parceiros atuam em projetos sustentáveis para áreas de reserva da Amazônia. Rondônia: [s. n.], 2004. Disponível em: <https://www.embrapa.br/busca-de-noticias/-/noticia/17968113/embrapa-eparceiros-atuam-em-projetos-sustentaveis-para-areas-de-reserva-da-amazonia>. Acesso em: 15 out. 2018.
- [91] WAWZYNIAK, João Valentin. Rondônia – Reserva Extrativista do Rio Ouro Preto: transformações nas formas de apropriação da natureza e estratégias de sobrevivência. *In: O destino da floresta: reservas extrativistas e desenvolvimento sustentável na Amazônia*. Rio de Janeiro: [s. n.], 1994.
- [92] WHATELY, Marussia; HERCOWITZ, Marcelo. **Serviços ambientais: conhecer, valorizar e cuidar**: subsídios para a proteção dos mananciais de São Paulo. São Paulo: [s. n.], 2008.
- [93] WWF-BRASIL. **Efetividade de gestão das unidades de conservação federais**: Avaliação comparada das aplicações do método RAPPAM nas unidades de conservação federais, nos ciclos 2005-06 e 2010. Brasília: [s. n.] 2012.
- [94] _____. **RAPPAM avalia efetividade de UCs de MS e MT**. Brasília: [s. n.], 2017. Nota publicada em 10 maio 2017. Disponível em: <https://www.wwf.org.br/?57802>. Acesso em: 4 fev. 2018.
- [95] ZAPPAROLI, Irene Domenes; CAMARA, Márcia Regina Gabardo. Plano de manejo florestal em uma propriedade do Mato Grosso: a teoria na prática. Rio Branco (Acre): [s. n.], 2008. *In: XLVI Congresso da Sociedade Brasileira de Economia e Sociologia Rural - SOBER*, 2008.

Analysis of Human Resources at A Sustainable Use Conservation Unit: Application of the "Human Resource Module" of the RAPPAM method - Rio Ouro Preto Extractive Reserve

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Abstract— This study sought to answer the following questioning: "What does the management plan (guiding document on conservation unit management) indicate about human resources in a sustainable use CU, according to the indicators from 'Module 09 - Human Resources' of the RAPPAM method - global benchmark for evaluating the effectiveness of protected area management?" **Methodology:** The study is characterized as descriptive, based on its subject matter; documentary, since institutional documents were used for its development, and qualitative, since it interprets a phenomenon. **Objective:** To assess what the ROP EXRES "Management Plan - 2014" indicates about human resources in a sustainable use CU, according to the indicators of "Module 09 - Human Resources" of the RAPPAM method. **Conclusion:** The study obtained the following results: a) the indicator "human resources" in the CU pointed to a gap due to the lack of professionals in sufficient numbers to meet the demands of the unit; b) in relation to "appropriate skills" of employees to carry out the work, the only EXRES employee was evaluated as having the appropriate qualifications; c) the indicator "management team training and development" revealed that the management plan has programs aimed at ongoing training of employees in order to meet the demands of the protected area; d) regarding the indicator "periodic review" of employees, it was observed that the plan does not cover or does mention this item; finally, with regard to the indicator "working conditions" available, the team shows few significant results, in view of the inadequate infrastructure in the management plan. This means that investments are needed to develop the structuration of the CU. The study advocates the importance of obtaining a broad picture regarding Brazilian protected areas due to the abundance of natural resources in such areas. The issue of human resources in protected areas is essential to their effective management, surveillance, service to community, and the study especially emphasizes community participation as a way to directly contribute to the management of protected areas. As a suggestion to contribute to the solution of the problem researched, this study points to the possibility of shared management being implemented in ROP EXRES, as is seen in other protected areas.

Keywords— Human Resources. RAPPAM Method. Management Plan.

I. INTRODUCTION

Human resources are essential in all segments of society be they in health, education, business or projects having to do with the environment. Given this, the current study seeks to carry out an analysis of human resources in a sustainable use conservation unit: the Rio Ouro Preto Extractive Reserve (ROP EXRES), located in the Amazon, in the state of Rondônia, northern Brazil.

The study seeks to answer five (5) questions on "human resources" of PAs:

- a) Is the level of staffing sufficient to effectively manage the CU?
- b) Do staff members have adequate skills to conduct critical management activities?
- c) Are the staff training and development opportunities appropriate to the needs of the PA?

- d) Are staff performance and progress on targets periodically reviewed?
- e) Are staff employment conditions sufficient to retain high-quality staff?

The questions mentioned above have been proposed through the method known worldwide as "Rapid Assessment and Prioritization of Protected Area Management" (RAPPAM); the method has been applied in Asia, Latin America, the Caribbean and other places. The guiding document to address the issues mentioned above is the so-called "Rio Ouro Preto Extractive Reserve management plan/RO - 2014", considered the basic management document for ROP EXRES. The RAPPAM method is a tool that has helped to assess the effectiveness of protected area management.

The study researches the following question:

"What does the management plan (guiding document on protected area management) indicate about human resources in a sustainable use CU, according to the indicators in 'Module 09 - Human Resources' of the RAPPAM method - world reference for evaluating the effectiveness of protected area management?"

The ROP EXRES management plan was designated as sample object of study to represent the problem. Since then, the problem studied has presented the following question: "What does the ROP EXRES "Management Plan - 2014" indicate about the human resources of this unit, according to the indicators in the "Human Resources Module" of the RAPPAM method?"

The relevance of this study should be noted since it can contribute in the following ways: I - improving the ROP EXRES management plan and serving as a reference for other protected areas across the country or around the world; II - serving as a guideline for the implementation of public policies for the promotion of human resources in protected areas of sustainable use; and finally III - contributing to the improvement of the quality of life of communities in protected areas, which benefit from them directly, as well as of society as a whole which indirectly utilizes environmental services made possible by PAs.

The study may also help in future updates of the ROP EXRES Management Plan, since the plan can be updated every 5 years. The plan herein studied and analyzed was published in 2014 and may incur updates as soon as 2019, with modifications or enhancements aiming towards achieving the unit's objectives.

The study is based on the need to care for and preserve the environment, which largely affects not only the global population, but also the physical environment of the entire planet Earth. Thus, the information herein

contained applies to the survival of life on the planet and preservation of the earth itself.

II. THE IMPORTANCE OF PROTECTED AREAS

Protected areas provide many benefits to humans, especially environmental conservation; however, the advantages of these protected areas go beyond this, since the creation of Conservation Units (CUs) also involves regional growth, maintenance of wildlife, better air and water quality, protection of historical and cultural sites, and also the conservation of water resources and scenic beauty, among other benefits.

In regards to the economic objectives that revolve around a CU:

Protected areas also have economic objectives embedded in their creation. Some practical initiatives have already shown an increase in job opportunities and income through the creation of new protected areas, which must be well managed, maintaining principles of orderly use and respect for the carrying capacity of the environment. Perhaps the most typical example of economic exploitation is tourism, adopted particularly by national parks which receive a large number of tourists every year (HASSLER, 2005, p. 87).

As mentioned above, protected areas account for various contributions: both to the environment and to people who use environmental resources and are benefited directly or indirectly by the preservation and conservation of protected areas. It is worth highlighting the main benefits of protected areas.

2.1 Main contributions of protected areas:

- a) Adjusting the quantity and quality of water for consumption;
- b) Soil fertility and stability of slopes (relief);
- c) Climate balance and maintenance of air quality;
- d) Healthy and diverse foods;
- e) Basis for the production of drugs for current and future illnesses;
- f) Green areas for recreation, education, culture and religion;
- g) Providing raw materials for various utilities.

Another good thing about CUs that should be noted is the generation of income, and the fact that they awaken regional and local development, including sustainable tourism programs, creation of eco-product cooperatives, among others, stimulating scientific research activities and instructional processes.

The categories of protected areas or protected spaces are created for a specific function, based on features that prove its protection. They can be used in two different ways:

- a) with regard to protecting natural or artificial beauty, thus maintaining the vegetation or animal life, or even human culture;
- b) use for leisure and entertainment, scientific knowledge and research.

The government has a fundamental role in environmental conservation, because through it one can create monitoring mechanisms and punishments for those involved in environmental crimes in protected areas. Currently, many of the public agencies and also much of society have realized the need for preservation and conservation of the environment to ensure the quality of life of the current population and future generations.

On the importance of municipal governments as a protective base for environmental resources, Tachizawa (2011) states that they have an indispensable role because they are closer to the people and more fragile ecological processes. They should understand environmental problems and consider them of utmost importance, taking some immediate management steps in the sector, for example: associating with environmental groups and environmental segments of companies to create an environmental monitoring system, while also working on environmental education programs in state and municipal schools. Another measure is to invest in the training of human resources that are involved in environment-related careers.

In short, PAs provide benefits beyond their borders. Therefore, the need for awareness on the part of public officials as to the importance of protected areas is evident so that ecosystems remain healthy; aiming to benefit the population through the creation of sustainable businesses, by providing sound economies and ultimately by resulting in the desired sustainable development.

III. TYPES OF CONSERVATION UNITS

Law No. 9,985 from July 18, 2000 created the National System of Nature Conservation Units (SNUC). According to this law, conservation units refer to natural areas passable for protection based on special features. In regards to the concept of CUs as defined by SNUC:

They are territorial spaces and their environmental resources, including jurisdictional waters, have relevant natural characteristics, legally instituted by the Government, with conservation objectives and defined limits, under special arrangements by public

officials, which is subject to appropriate guarantees of protection by law (BRAZIL, 2000, p. 01).

The division of conservation units established by SNUC falls into two categories, according to each unit's goals and usage type, namely:

- a) full protection;
- b) sustainable use.

a) Full protection conservation units: The full protection group has as its main purpose the preservation of nature. The use of natural resources is indirect; it is one that does not allow consumption, collection or damage to natural resources. Some examples of prohibited activities herein include: any activities in contact with nature, ecological tourism, scientific research, environmental education and interpretation, among other activities.

b) Sustainable use conservation units: Units of the sustainable use group aim to reconcile nature conservation with sustainable use of environmental resources, associating human presence in protected areas. Unlike the previous group, activities involving the collection and use of natural resources are accepted, done in such a way that renewable environmental resources and ecological processes are maintained.

3.1 The group of full protection CUs is divided into:

- a) Ecological Station (ESEC);
- b) Biological Reserve (REBIO);
- c) National Park (PARNA);
- d) Natural Monument (MONA);
- e) Wildlife Haven (REVIS).

With regards to the objectives related to conservation units of the full protection group:

- a) Ecological Station (ESEC):

Its purpose is the preservation of nature and the conduct of scientific research;

- b) Biological Reserve (REBIO):

Its objective is the preservation and restoration of a natural balance, biological diversity and natural ecological processes without direct human interference or environmental changes;

- c) National Park (PARNA):

It seeks to preserve natural ecosystems and their scenery. It provides an area for scientific research, environmental education and eco-tourism;

- d) Natural Monument (MONA):

It has the function of preserving rare natural sites or those of great scenic beauty;

- e) Wildlife Refuge (REVIS):

It is responsible for protecting natural habitats for flora and the reproduction of resident or migratory fauna.

3.2 Sustainable use CUs are divided into:

- a) Environmental Protection Area (APA);
- b) Relevant Ecological Interest Area (ARIES);
- c) National Forest (FLONA);
- d) Extractive Reserve (EXRES);
- e) Wildlife Reserve (REFAU);
- f) Sustainable Development Reserve (RDS);
- g) Private Natural Heritage Reserve (RPPN).

With regards to the objectives related to sustainable use protected areas:

- a) Environmental Protection Area (APA):

It has the function of protecting biological diversity, regulating the process of human occupation and ensuring the sustainable use of natural resources;

- b) Relevant Ecological Interest Area (ARIE):

It is responsible for maintaining ecosystems and regulating the use of these areas with extraordinary natural characteristics or those containing rare specimen of regional biota;

- c) National Forest (FLONA):

Its function is to promote sustainable multiple use of forest resources, scientific research and public visitation, with a special focus on methods for sustainable exploitation of native forests;

- d) Extractive Reserve (EXRES):

It aims to protect the livelihoods and culture of traditional populations and ensure sustainable use of natural resources;

- e) Wildlife Reserve (REFAU):

It is responsible for promoting studies on the sustainable management of wildlife resources;

- f) Sustainable Development Reserve (RDS):

Its objective is the preservation of nature improving the quality of life of traditional populations;

- e) Private Natural Heritage Reserve (RPPN):

It seeks to preserve biological diversity in private areas.

IV. HISTORY OF THE RIO OURO PRETO EXTRACTIVE

The Rio Ouro Preto Extractive Reserve (ROP EXRES) is among the first conservation units of the sustainable use group created in Brazil. Its location is in the municipalities of Guajará Mirim and Nova Mamore in the state of Rondônia, and it is part of the state's largest block of protected areas.

In Guajará Mirim, one arrives at the Reserve by Mamore and Ouro Preto rivers or by road, through an

extension of 40 km leading to "Lake Pompey" on the Rio Ouro Preto. ROP EXRES has an approximate area of 204,583 (two hundred and four thousand, five hundred eighty-three) hectares, bordered on the North by indigenous land and the Guajará Mirim State Park; on the east by the indigenous land Uru-eu-wau-wau; the South and West by the Rio Ouro Preto State Biological Reserve and the new Pacaás State Forest Extractive.

The first meeting of rubber tappers from Guajará Mirim in February 1989 was a highlight for the creation of the extractive reserve; the purpose of the meeting was to discuss the problems related to the city's rubber tappers and choose representatives for the second national meeting of rubber tappers. At that time there was no form of political organization for rubber tappers in the city.

According to Wawzyniak (1989), 278 (two hundred seventy-eight) rubber workers attended the meeting, of whom 167 (one hundred sixty-seven) were from Rio Ouro Preto, and representatives of governmental and non-governmental organizations were also included. The rubber tappers' meeting meant an opportunity to discuss the main problems faced by the population, as follows:

- a) lack of assurance regarding placement;
- b) low price of rubber and high commodity prices;
- c) payment of income and lack of health care and education;
- d) deforestation.

Among all the claims mentioned by the rubber tappers, the main ones were: a better price for rubber, ensuring permanence in placements, end of income payment, and creation of a cooperative health care and education system.

During the meeting a Municipal Commission was established with the task of extending the organization and sending claims.

At the end of 1989, the State Forestry Institute (IEF) suggested the creation of a protected area with 54,000 (fifty-four thousand) hectares. However, through a map displayed, it was found that it represented a small strip located on the river banks and did not cover areas of land, the few existing nut trees and streams occupied by rubber tappers. Upon analysis, the IEF extended the area to 204,583 (two hundred and four thousand, five hundred eighty-three) hectares.

The spread of the idea of an EXRES addresses the security of the remaining subjects discussed at the first rubber tapper meeting in Guajará Mirim (RO). It is evident that EXRES benefits a project of autonomy; this can be seen through the life changes of the rubber tappers

who are now independent, i.e. do not need to be subjected to an employer.

Note that extraction work was not always the focus of the local economy, or a base to generate income. It appears that since the creation of the EXRES in 1990, until today, latex extraction has declined as the main source of survival. Thus, extraction activity took second place as a source of income in the unit; agricultural work moved to the lead, and additionally, hunting and subsistence fishing, in a diverse utilization of resources. The activities take place concurrently or alternately throughout the year, subject to environmental or socioeconomic factors.

V. METHODOLOGY

The ROP EXRES management plan was created in 2014, i.e. it is a legal framework considered to be recent. As a very important document for CU management, this study analyzed what the plan addresses with regard to the issue of human resources. Analysis was performed in order to answer the questions contained in "Module 9 - Human Resources" of the RAPPAM method. The document used is the "Rio Ouro Preto Extractive Reserve Management Plan/RO 2014"; upon analysis of the aforementioned document, it was possible to answer the questions of the RAPPAM method, in view of the fact that the document includes points of CU management statutory standards.

This study analyzed one of the most important protected areas in the Brazilian Amazon region: ROP EXRES. It is worth noting that this CU was one of the first of its type created in Brazil (03/13/1990). The first EXRES created in Brazil was Alto Juruá (Acre - on 01/23/1990); the second, also located in Acre, was the Chico Mendes EXRES (03/12/1990) and the third was established in Amapá - Rio Cajari EXRES (03/12/1990). ROP EXRES is located in a border area between Brazil and Bolivia; thus, the body responsible for management should take caution because of threats to which the area is exposed, including, for example, exploitation and plundering of the environment, as well as invasion pressures.

The study was conducted in order to examine the following question: What does the ROP EXRES "Management Plan - 2014" indicate regarding the characterization of human resources of a sustainable use CU, based on the indicators of "Module 9 - Human Resources" from the RAPPAM method?

The methodology used to provide the data gains its theoretical basis, in the foundations of Gonçalves (2007). The author classifies a study based on the segments that structure it, namely:

- a) its objectives;
- b) its data collection procedures;
- c) its sources;
- d) the nature of the data collected.

Thus, this study is embodied in the following classifications:

5.1 According to its objective this is a - Descriptive Study

This study is classified as descriptive based on its objectives because its subject matter is analyzed by descriptions. Therefore, it is an analysis of an objective, i.e. a descriptive approach to focus on the object of study.

It is noteworthy that this type of study is of great importance in view of the meager existence of studies on the subject matter. The theme features the description and provides data that can be used as a contribution to further analysis of the object of study.

The object to be described in this study are the human resources from the ROP EXRES Management Plan (2014), in order to answer the questions in the RAPPAM method questionnaire, containing five (5) questions from the section entitled " module 9 - Human Resources ".

5.2 According to its data collection procedures this is a – Documentary Study

The procedures used to produce data in this study were based on the following steps:

Step 1 - Study of Document 1 (one) entitled "Rio Ouro Preto Extractive Reserve Management plan /RO - 2014" to identify all the parts of the plan that address human resources in ROP EXRES;

Step 2 - further studies on documents two (2) and three (3) entitled:

b.1) Document 2: "Effectiveness of Federal Protected Area Management - comparative evaluation of the applied RAPPAM method in federal conservation units in cycles from 2005-2006 and in 2010 - Full version report - February 2012;

b.2) Document 3: Evaluation of Protected Area Management: RAPPAM (2015) and SAMGE (2016) methods.

Step 3 - application of "Module 9 - Human Resources" from the RAPPAM method questionnaire: search for answers in document 1 above, the management plan,

guided by the 5 indicators found in the RAPPAM method's survey questions:

- a) *Are there human resources in sufficient numbers for the effective management of the CU?*
- b) *Do staff have appropriate skills to carry out management actions?*
- c) *Are there opportunities for training and staff development, appropriate to the needs of the PA?*
- d) *Is there periodic assessment of the performance and progress of employees?*
- e) *Are the working conditions sufficient to maintain adequate staff for the goals of CU?*

Step 4 - description of the solutions found in the PA management plan regarding ROP EXRES objectives;

Step 5 - record, along with the description in the previous step, external theoretical contributions to the Management Plan (books, papers, theses, dissertations) in order to compare the data obtained.

Note that the 4 steps mentioned above were based on the use of institutional documents, known as primary sources, meaning documents prepared by organizations or government agencies; therefore, this study is classified as documentary research.

5.3 According to the sources of information this is a – Documentary Study

The study is characterized as being of the documentary type based on the source from which the information was obtained, i.e., with the same reasoning laid out in the previous paragraph, original publications from institutional bodies were used. Using the information obtained from the ROP EXRES management plan, the data were processed and analyzed.

5.4 According to the nature of the data this is a - Qualitative Study

In summary, the data presented can be classified in two ways based on their nature: qualitative data or quantitative data.

Quantitative data are those that point to numerical characteristics, statistics or percentages in the experiments; through these data, values are assigned, giving them a numerical order. Another feature of quantitative data that is worth mentioning is deduction in analyzing the cause of the phenomena. Therefore, the use of experiments is carried out in a controlled manner, so

that the analyst can check and validate the results obtained even if numerous tests of the hypothesis and its variants are needed. This study is of qualitative nature, as opposed to a quantitative study.

Qualitative data are those that make an analysis based on interpretation of the phenomenon, i.e., the data seek to establish a connection with the environment to which they belong; moreover, analysis establishes relations with the perception that individuals have of the phenomenon and the context in which it is inserted.

Note that for the reasons stated in the previous paragraph, this study is defined as qualitative research, since interpretations were made about content and principles in legal compositions, in particular the guiding document of this study: "Rio Ouro Preto Extractive Reserve Management Plan/RO 2014 ". For the above reasons, the study took the form of a hermeneutic approach.

The community's contribution to the wording of the text in the ROP EXRES management plan occurred from their practices, their relation with the CU, that is, the knowledge and experience of the reality in which they live. This is a point similar to qualitative research.

5.5 About the RAPPAM method:

The World Commission on Protected Areas - WCPA in 1995 established a meeting with researchers from different specialties in order to discuss and develop methods related to environmental protection. Based on this meeting and the information obtained a framework was established that became the model for developing methods to assess protected area management, based on three pillars: a) planning; b) implementation c) evaluation.

The RAPPAM method was based on the model set out in the preceding paragraph; the World Wide Fund for Nature (WWF) developed the Rapid Assessment and Prioritization of Protected Area Management (RAPPAM), a device that aims to help managers of protected areas. The RAPPAM method allows for quick and efficient evaluation of PAs, and is able to identify positive and negative points that deserve attention by managers, i.e. it contributes to the analysis of these points and also provides the basis for the development of public policies consistent with protection of natural resources in each unit.

WWF-Brazil is a non-governmental Brazilian organization dedicated to nature conservation; its purpose is to minimize negative impacts of human activities acting this way in order to protect Brazilian biodiversity. Environmental protection in protected areas is a challenge

for managers; however, the importance that these areas have is not only a concern for those who are directly responsible for the management, but the areas also deserve attention from institutions around the world, like for example, WWF. This subject of preservation of protected areas is so important that it is a topic discussed recurrently in conferences and scientific studies worldwide.

The importance of WWF-Brazil since its creation in 1996 should be noted; together with NGOs and other institutions, several projects dedicated to the cause of environmental protection have been carried out. The institution includes studies on environmental degradation and the development of research projects to solve the problem (WWF, 2012).

The RAPPAM method is an important tool for evaluating the effectiveness of management in protected areas; since its creation in 2002, RAPPAM has already been applied in many countries due to the good results it has obtained. In Brazil the method was first applied in 2004; the goal was to evaluate the following protected areas: protected areas of the Paraíba Valley, Ribeira Valley, Serra da Mantiqueira, Upper Paranapanema and the metropolitan area of the capital, in São Paulo. Implementation of the method in federal units located in the Amazon began in the year 2005.

The partnership between WWF-Brazil and IBAMA made the application of the RAPPAM method possible in 2005 and 2006 in federal conservation units, more specifically those located in the Amazon region. In the application cycles of the years 2005, 2010 and 2015 ROP EXRES was evaluated using the above method.

In summary, evaluation of the effectiveness of management through the RAPPAM method examines whether the activities developed are compatible with the needs of protected areas, in order to ensure that their objectives are achieved. For this purpose, RAPPAM lists a structure of its questionnaire consisting of five elements of the management planning, and evaluation cycle (input, context, planning, process and output); each element mentioned addresses a different topic that is evaluated with its own thematic module.

RAPPAM is an instrument recognized worldwide for containing a framework for evaluating protected area management quickly and efficiently; the method also has a mathematical formula responsible for obtaining a management effectiveness index. However, this study addressed the Human Resources thematic module. Thus, the study focused on answering the questions addressed in the above-mentioned module contained in the RAPPAM questionnaire.

The following image shows the classification of each thematic module based on its exposed elements:

Table 1 - Structure of the RAPPAM questionnaire

Elemento	Módulo temático
Contexto	1. Perfil
	2. Pressões e ameaças
	3. Importância biológica
	4. Importância socioeconômica
	5. Vulnerabilidade
Planejamento	6. Objetivos
	7. Amparo legal
	8. Desenho e planejamento da área
Insumos	9. Recursos humanos
	10. Comunicação e informação
	11. Infraestrutura
	12. Recursos financeiros
Processos	13. Planejamento
	14. Processo de tomada de decisão
	15. Pesquisa, avaliação e monitoramento
Resultados	16. Resultados

Source: WWF-Brazil, 2012, p. 12.

Through the RAPPAM method questionnaire, divided into the five (5) elements described above, factors that are relevant to protected area management can be analyzed. One interesting fact is that the questions in the questionnaire are applied directly to employees and the community, which assigns a degree of reliability, given that they are the people who experience the reality of these areas daily, and know their problems and aspirations.

In the structure of the RAPPAM questionnaire, the element "Inputs" contains four thematic modules, namely:

- a) Module 9 - Human Resources;
- b) Module 10 - Communication and information;
- c) Module 11 - Infrastructure and
- d) Module 12 - Financial resources.

Module 9 - "Human Resources" was chosen as the central focus of this study; this module addresses the following questions:

- a) Are there human resources in sufficient numbers for the effective management of CU?
- b) Do the staff have appropriate skills to carry out management actions?
- c) Are there opportunities for staff training and development that are appropriate to the needs of the PA?

- d) Are there periodic assessments of employee performance and progress?
- e) Are the working conditions sufficient to maintain adequate staff for the goals of the CU?

Section 6 below will address each of the questions in "Module 9 - Human Resources" with the results found in the ROP EXRES management plan in the form of answers to the questions proposed. Each question was transformed into a subheading in section 6.

VI ANALYSIS OF "MODULE 9 - HUMAN RESOURCES" FROM THE RAPPAM METHOD

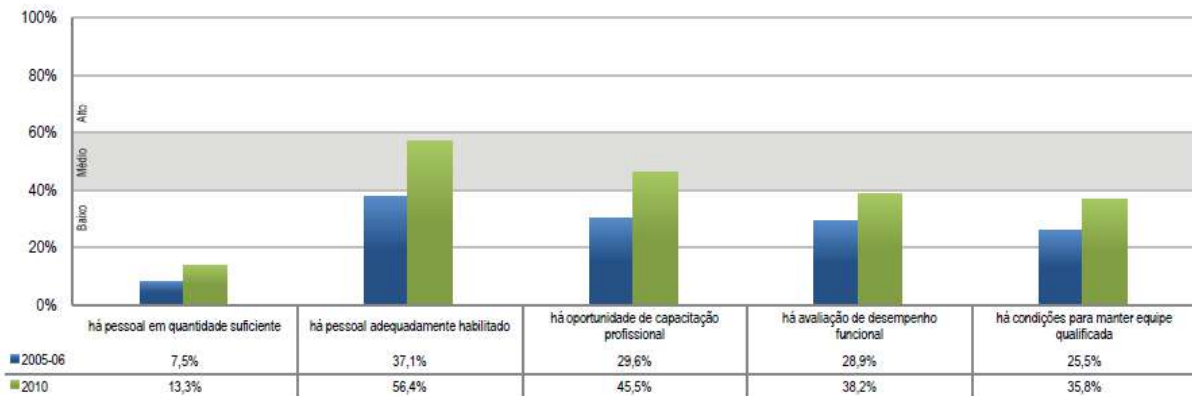
Three charts were considered as part of this analysis: the first referring to federal conservation units, the second referring to federal sustainable use protected areas and the third and last referring to extractive reserves. All are located in Brazil. Data were extracted from WWF, IBAMA and ICMBio reports on the assessment of the effectiveness of protected area management, performed

via the RAPPAM method in the 2005/2006 and 2010 cycles.

The graphics from the 2015 RAPPAM cycle were not available. The report underwent a change that altered its presentation; the Brazilian government's own method for assessing management effectiveness was issued as well: the Management Analysis and Monitoring System (SANGe). This partnership ended by suppressing the detailed graphics displayed previously in the reports from the 2005/2006 and 2010 cycles. In addition, the RAPPAM method was applied in 2015, SANGe in 2016 and the disclosure of both reports were not published nor made available by the Brazilian government until November 2017.

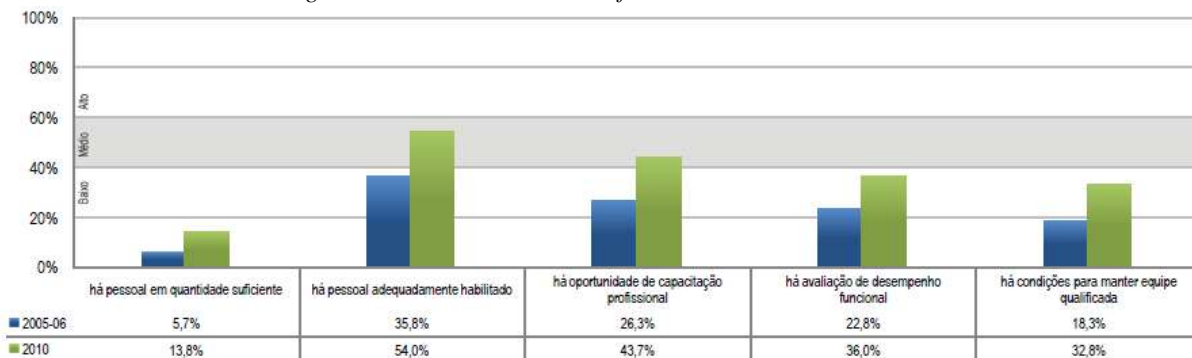
The three (03) following charts were used to analyze "Module 9 - Human Resources" from the RAPPAM method applied to ROP EXRES. 06 (questions) submitted by the RAPPAM method will herein be discussed as this study seeks to reference and contextualize the reality of a federal extractive reserve conservation unit for sustainable use.

Figure 1 - Human resources in federal CUs



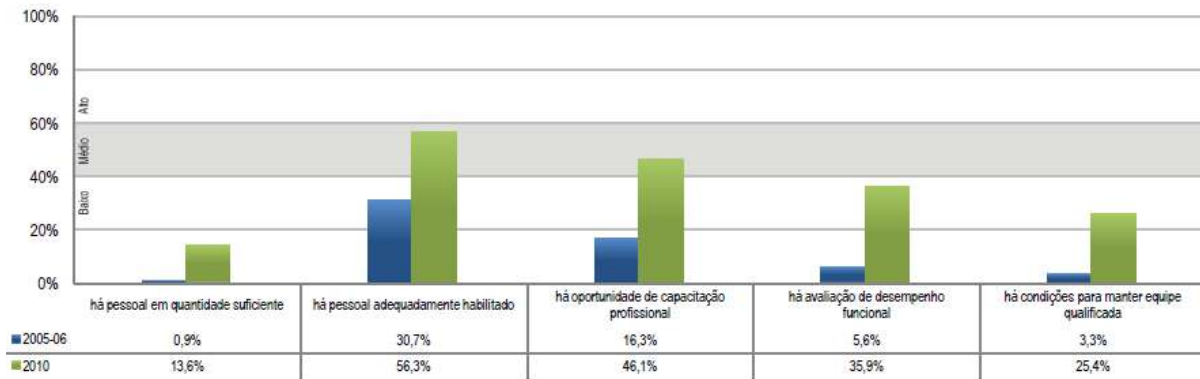
Source: RAPPAM Report 2005/2010 Cycle

Figure 2 - Human resources in federal sustainable use PAs



Source: RAPPAM Report 2005/2010Cycle

Chart 3 - Human resources in extractive reserves



Source: RAPPAM Report 2005/2010 Cycle

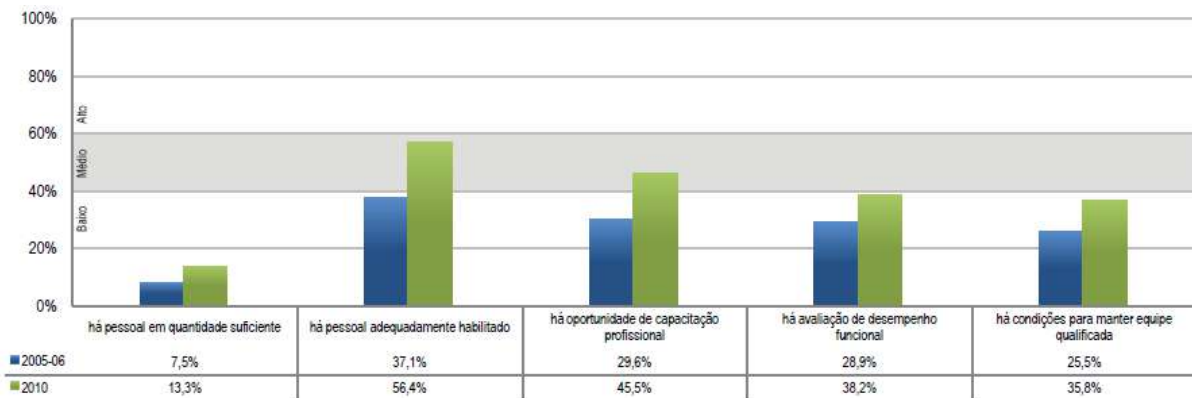
6.1 QUESTION "A" FROM "MODULE 9 - HUMAN RESOURCES" THE METHOD RAPPAM: ARE THERE HUMAN RESOURCES IN SUFFICIENT NUMBERS FOR EFFECTIVE MANAGEMENT OF THE CU

According to analyses of the 2014 ROP EXRES management plan, the number of human resources available for the unit’s management is scarce: one (1) employee to maintain the entire EXRES. However, the document contains the strategic map of the CU, where future goals are listed, especially those for the next five (5) year period. One of the presented goals is to expand the number of collaborators and employees. Therefore, the amount of human resources for management of the area is not enough; however, the diagnosis made resulted in strategic objectives identified by the management plan. Given the year the management plan was prepared (2014), it’s important to consider which results have been achieved and what still needs to be improved.

The Rapid Assessment and Prioritization of Protected Area Management (RAPPAM) method applied

in the years 2005/2006/2010 addressed important questions about the evaluation of the effectiveness of management in federal and state conservation units. From a comparative analysis we note that in relation to other evaluated modules from the RAPPAM method, human resources did present progress between application cycles; however, the results are still not satisfactory.

Chart 1 - Is there enough staff in the federal protected areas?

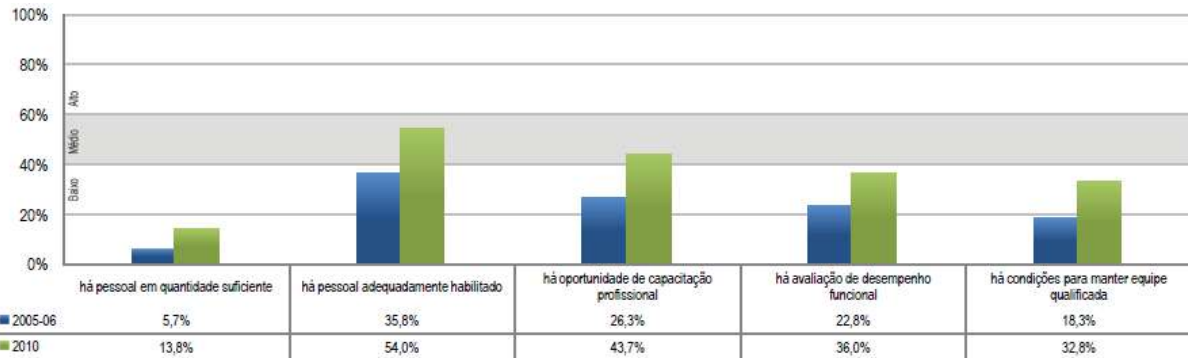


Source: RAPPAM Report 2005/2010 Cycle

Figure 1 refers to human resources in the federal protected areas as a whole; it is clear that the 2005/2006 RAPPAM cycles with regards to the item "There are people in sufficient quantity", shows 7.5% in 2010; the index rose to 13.3% which means an increase of 5.8%. It

was not a very significant step forward; that is, this is an area that needs more investment.

Chart 2 - Is there enough staff in the federal sustainable use protected areas?

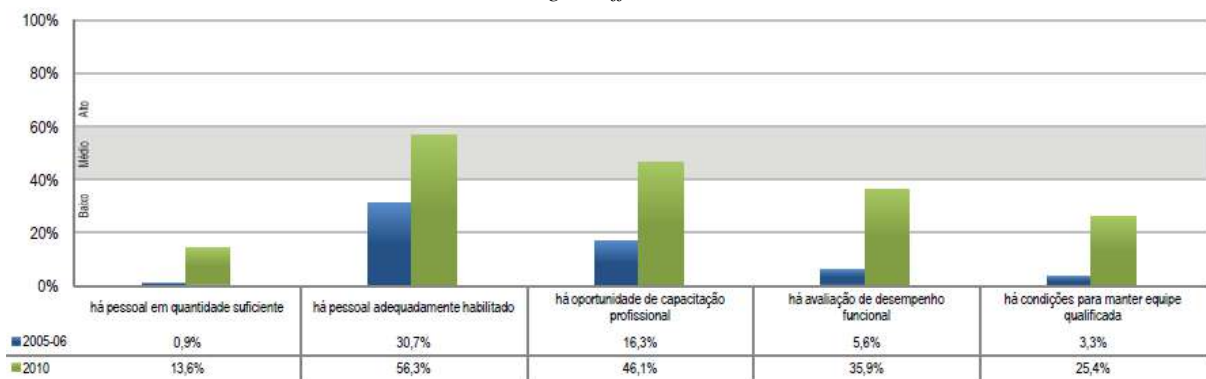


Source: RAPPAM Report 2005/2010 Cycle

The RAPPAM method assessed the human resources specifically in the "federal sustainable use protected areas" category. Graph 2 shows that in the 2005/2006 cycles, the amount of sufficient staff in the units was just 5.7% which is a very worrisome percentage, while in 2010 the percentage rose to 13.8%; it is clear that this increase was low: just 8.1%. It is important to note that this is defined as a low level of

effectiveness, i.e. less than 40%. These data represent an important issue from the point of view of protected area management, and therefore, directly affect the conservation of these environments.

Chart 3 - Is there enough staff in the extractive reserves?



Source: RAPPAM Report 2005/2010 Cycle

From the perspective of "human resources in extractive reserves", the RAPPAM method also pointed out the percentage of human resources. In Figure 3 the alarming rates continue, the number of staff in sufficient numbers in the Exres in application cycles 2005/2006 is only 0.9%, i.e. a low percentage, while in 2010 the amount increased to 13.6 %, a 12.7% increase. No doubt it is an item that needs to be analyzed by protected area management teams. It is very important that these data are

continually monitored, in order to contribute to the reversal of the current critical situation to a satisfactory level of framework and quality.

Based on the analyses performed by the RAPPAM assessment of protected areas on a federal level, including those of sustainable use and in particular extractive reserves, extremely low percentages prevail over the number of staff in protected areas. This represents a gap in the effective management of protected areas which

have too few human resources to carry out the monitoring of such environments.

ROP EXRES is managed by the Chico Mendes Institute for Conservation of Biodiversity (ICMBio), in partnership with two community associations, which are: the Association of Rubber Tappers and Agroextractives from the Lower Rio Ouro Preto (ASAEX) and the Association of Rubber Tappers from Rio Ouro Preto (ASROP). The importance of the association is worth mentioning, considering the fact that both play very important roles for community residents of the CU, they represent those associated with the struggle for socio-economic rights and intercede in favor of a policy for rubber and other extractive products.

The EXRES management agreement was created based on workshops and meetings in communities, in a participatory manner. This agreement aims to ensure the self-sustainability of the CU, and to lay down rules by which the use of natural resources is guaranteed and duties to be fulfilled by residents are defined. Through this agreement it is possible to have management control of the CU; since the people who live there will be responsible for complying with the rules and also monitoring other residents, this can be considered a positive aspect in the management of the extractive reserve.

ROP EXRES has a deliberative council, which has a stake of 26 (twenty-six) members, and is headed by ICMBio, which is the body responsible for managing it. Participants of the board are composed of various sectors such as government agencies, civil society and traditional populations. The importance of the board should be noted because it is through the board that the CU can be connected with other units and protected areas. The following are council members:

- I - Chico Mendes Institute for Conservation of Biodiversity, one member and one alternate;
- II - State Secretary of Environmental Development - SEDAM/RO, one member and one alternate;
- III - Municipal Government of Nova Mamoré/RO, one member and one alternate;
- IV - National Indian Foundation - FUNAI/Regional Coordination of Guajará Mirim/RO, one member and one alternate;
- V - Municipal Government of Guajará Mirim / Municipal Secretary of the Environment - SEMMA, one member and one alternate;
- VI - Federal Police in Guajará Mirim/Regional office in Rondônia/Federal Police Department, one member and one alternate;

- VII - Military Police of the State of Rondônia/Environmental Police Battalion, one member and one alternate;
- VIII - INCRA - Regional Superintendent of the State of Rondônia-SR-17/RO;
- IX - Association of Rural Assistance and Extension of the State of Rondônia - EMATER, one member and one alternate;
- X - Association of Rubber Tappers and Agro-Extractives of the Lower Rio Ouro Preto - ASAEX, one member and one alternate;
- XI - New Hope Community, one member and one alternate;
- XII - Organization of Rondonian Rubber Tappers - OSR, one member and one alternate;
- XIII - Association of Rubber Tappers of the Rio Ouro Preto Extractive Reserve - ASROP, one member and one alternate;
- XIV - New Colony Community, one member and one alternate;
- XV - Extension of the Apes Community, one member and one alternate;
- XVI - Good Jesus Community, one member and one alternate;
- XVII - Petropolis Community, one member and one alternate;
- XVIII - Ouro Negro Community, one member and one alternate;
- XIX - Forest Community, one member and one alternate;
- XX - National Council of Extractive populations - CNS, one member and one alternate;
- XXI - Divine Holy Spirit Community, one member and one alternate;
- XXII - Three Josephs Community, one member and one alternate;
- XXIII - Pompey Community, one member and one alternate;
- XXIV - Sepetiba Community, one member and one alternate;
- XXV - Our Lady of Rubber Tappers Community;
- XXVI - Association of Agro Açaí Producers of Guajará Mirim - ASAGUAM, one member and one alternate (BRAZIL, 2014, p. 103).

In 1991, residents of the CU ROP EXRES, the State of New Pacaás River Reserve and the New River, participated in the Rubber Tappers Association of Guajará Mirim (ASGM). At that time the ASGM represented all the rubber tappers from different areas. But a few years later, the National Center for Research and Conservation

of Sociobiodiversity (CNPT) and the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) recognized the need for a specific Association for the Rio Ouro Preto EXRES. Thus, ASROP was created due to the fact that transfers of funds are different, i.e. federal nature transfers to federal reserves and state nature transfers to state reserves; thus, they could not be considered the same group.

After the creation of ASROP came another association, also part of ROP EXRES, ASAEX. At first there was a territorial division between the two associations; one of the criteria used by the locals to associate themselves with one or the other was based on political relationships.

In 2002, the scope of each Association was defined on the river. ASROP became the representative body of the upper river, and the low river went to ASAEX. The definition of territorial associations was related to reports that both associations have to present based on the use of resources in projects. These representative bodies are directly linked to internal and external political discussions and participate in matters that are within their jurisdiction; they are members of the EXRES board and assist in preparing the management plan.

In 2007, a socio-economic survey was carried out by ICMBio in order to quantify the EXRES population. It accounted for 583 (five hundred eighty-three) inhabitants and 157 (one hundred fifty-seven) families. 56.6% were men and 43.4% women. According to the ICMBio the area of the reserve is 204,631.55 (two hundred and four thousand, six hundred thirty-one hectares and five thousand five hundred square meters), highlighting the need for human resources in large numbers managing the CU. It is a significant area in scope and has few inhabitants, who play a key role by acting as monitors and often inspectors of such an environment. More human resources could contribute to the unit's governing body, which has difficulty in monitoring such a large area by itself.

For the coming years, the ROP EXRES management plan outlined strategic goals and a mission for the future, stipulating a period of five (5) years to fulfill these objectives. The management plan emphasizes the need to increase the number of servers and collaborators, so that efficient management is carried out. Although there is a deliberative body with many members, this is not enough to meet the demand of the EXRES; therefore, each member is responsible for a distinct function. I.e., there is

one (1) member who represents the municipalities (Guajará Mirim, Nova Mamore), one (1) representative from ICMBio and so it is with all other representatives of the board, there is only one (1) seat holder for each member.

Human resources in the EXRES are paramount, since there is a lack of monitoring of environmental resources, i.e., with a larger number of employees there would be tighter control on the use of protected areas and protection of these environments.

6.2 QUESTION "B" FROM "MODULE 9 - HUMAN RESOURCES" OF THE RAPPAM METHOD: DO EMPLOYEES HAVE THE PROPER SKILLS TO CARRY OUT MANAGEMENT ACTIONS?

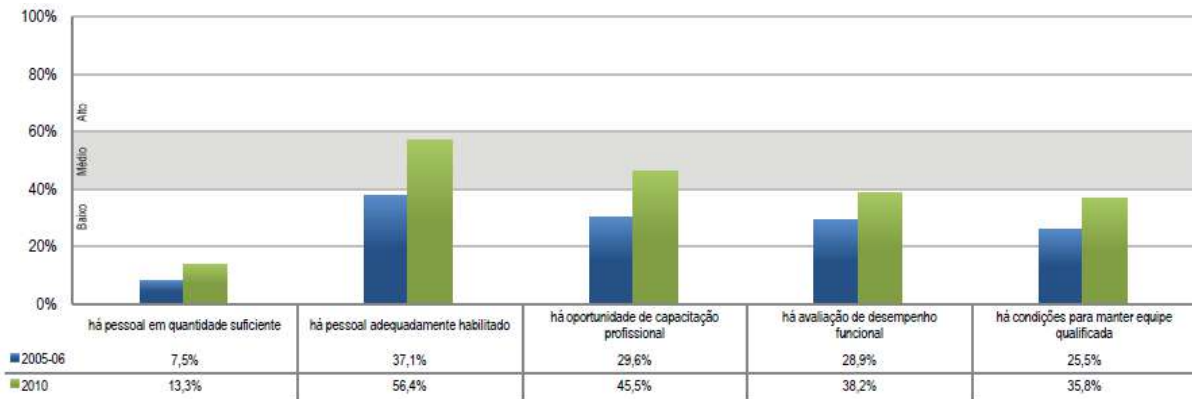
The reserve has only one employee, Mr. Albino Batista Gomes. He belongs to ICMBio, is a career employee stationed in the state of Minas Gerais and exercises a commissioned position (ICMBio Position of Confidence, Conservation Unit, Level: Head DAS) Head of ROP EXRES with housing in the municipality of Guajará Mirim, in the state of Rondônia, which is located on ROP EXRES.

The only employee of the Exres has been an Environmentalist Specialist since 1982, with a master's degree and doctorate in the area of Teaching and Learning. He participated in different trainings made possible by ICMBio directed toward the functions which he develops as head of ROP EXRES. However, only one employee is insufficient to legitimize the Exres management actions appropriately.

On the other hand, the body responsible for managing ROP EXRES, as a federal CU is ICMBio; the unit has a governing board composed of representatives from different segments of society, so those responsible for managing the protected area have the necessary skills for this role.

Representatives of the board are people who are experienced for the position because they are employed by the public bodies which they represent within the board, such as universities, municipal departments, state departments, municipal governments, indigenous institutions, federal police, military police, and associations, among others. The reserve's community is also on the board; that is, these are people who have the capacity to carry out activities and projects for the final purpose of effective CU management.

Chart 4 – Are there adequately trained personnel in federal protected areas?

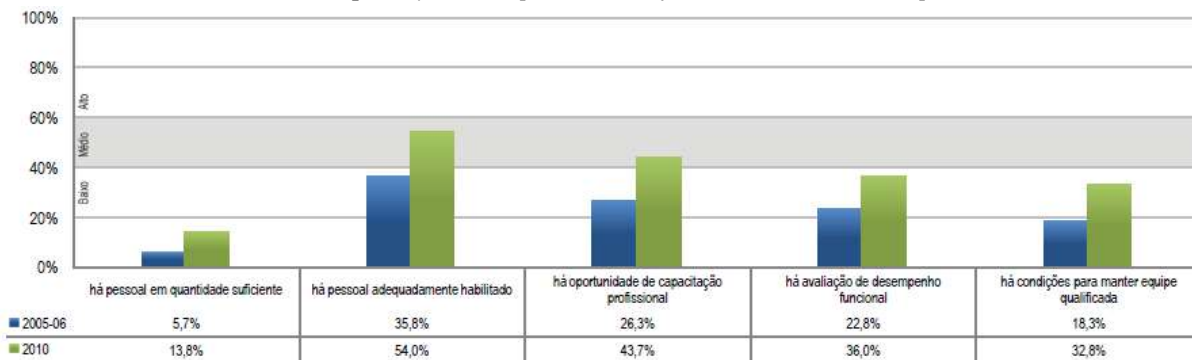


Source: RAPPAM Report 2005/2010 Cycle

Regarding the topic "There are adequately trained staff" to conduct proceedings in federal protected areas, in the years 2005/2006 there was a total of 37.1%, while in 2010 the percentage increased to 56.4%, i.e., increased by 19.3% within five (5) years. Note that this is not the expected result, since it falls within the effective average

rate (between 40% and 60%), while the ideal percentage would be above 60%, which is considered a high level of effectiveness. However, these are certainly important advances in the management of protected areas.

Chart 5 - Are there adequately trained personnel in federal sustainable use protected areas?

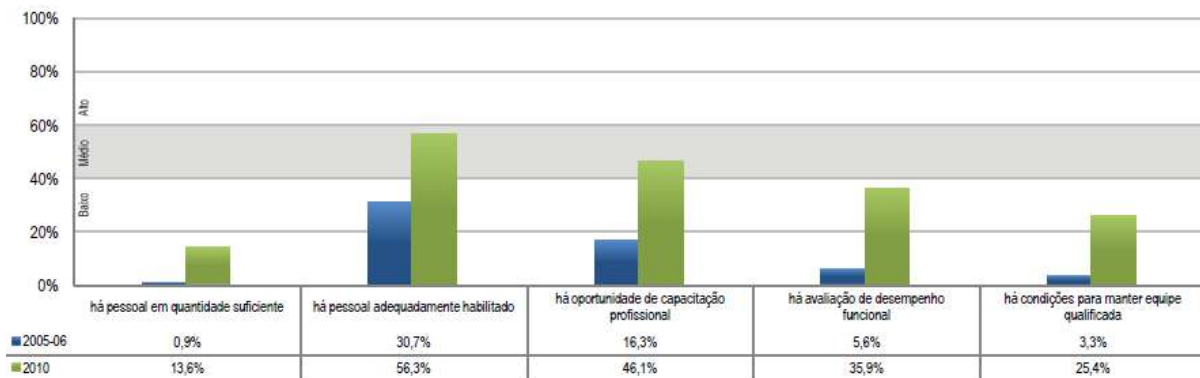


Source: Cycle RAPPAM Report 2005/2010

In regards to the topic, "There is properly qualified staff" in sustainable use protected areas, in the years 2005/2006 the rate was 35.8%; in 2010 the index increased to 54%, achieving an increase of 18% between the two periods. The increase is meaningless if one considers the importance of the topic in question.

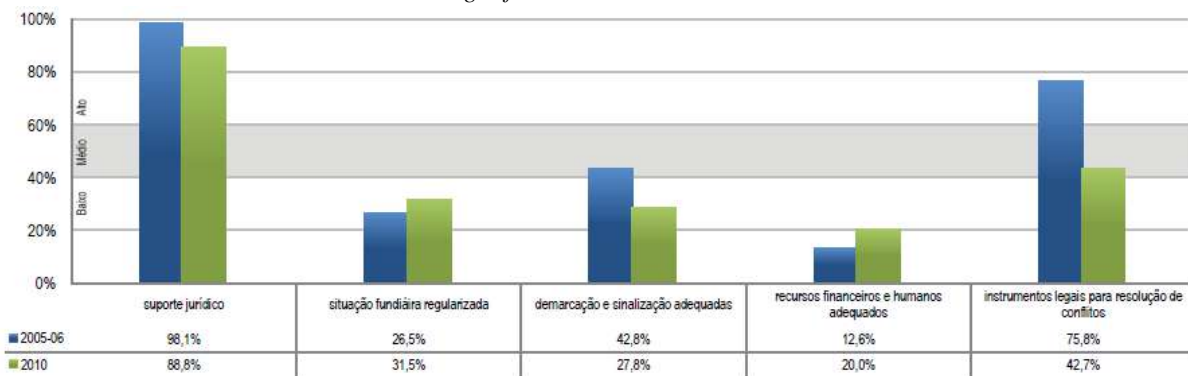
Professional unpreparedness can compromise an entire management team due to a lack of adequate technical knowledge.

Chart 6 – Are there adequately trained staff in the extractive reserves?



Source: RAPPAM Report 2005/2010 Cycle

Chart 7 - Legal framework in extractive reserves



Source: RAPPAM Report 2005/2010 Cycle

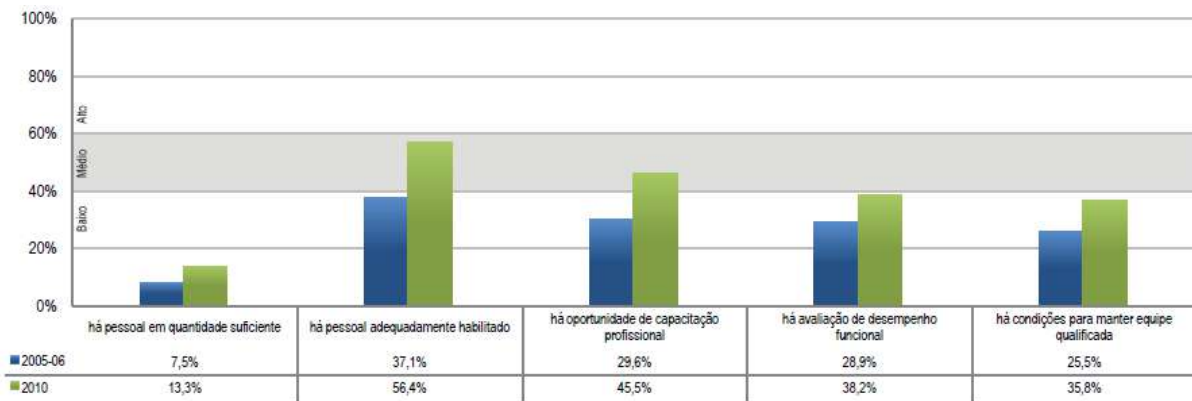
Chart 7 shows information regarding legislation in the extractive reserves, exposing whether or not there are "financial and human resources" in these units. The RAPPAM evaluation explained that in 2005/2006 the amount was 12.6%; it is understood that in this period the EXRES had little support in this regard, since there was an insufficient number of human and financial resources for legal support when compared to the demand. In 2010 the amount increased to 20%, achieving a growth of 7.4%.

6.3 QUESTION "C" FROM "MODULE 9 - HUMAN RESOURCES" OF THE RAPPAM METHOD: ARE THERE TRAINING AND TEAM DEVELOPMENT OPPORTUNITIES, APPROPRIATE TO THE NEEDS OF THE CU?

The management plan indicates a program on management and administration, in turn, through the infrastructure and staff sub-program which listed the priority actions to be developed, among which the ongoing training of the team of ICMBio servers is emphasized with priority for matters relevant to the CU. The document also addresses the need to support the training of association directors, citing ASAEX and ASROP; i.e., there is a concern in regards to training, extending through courses to ROP EXRES employees.

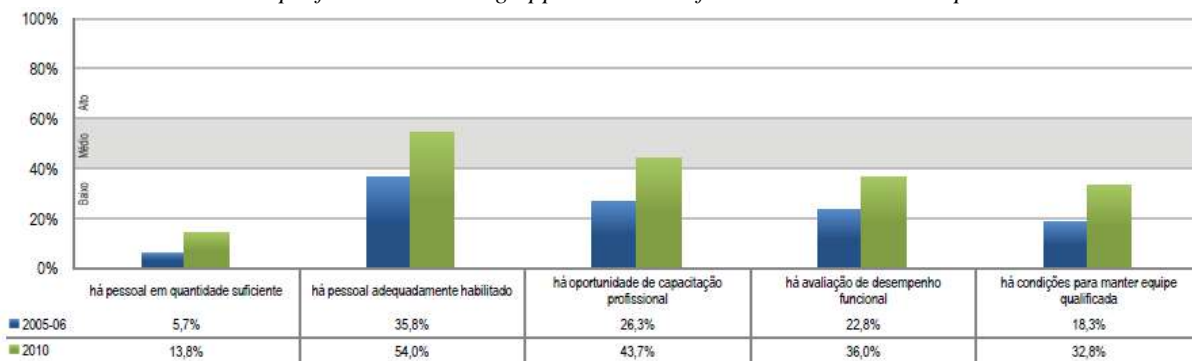
Note that the plan refers to all who directly or indirectly contribute to the unit's management, and therefore require appropriate skills to carry out management actions.

Chart 8 – Are there professional training opportunities in federal protected areas?



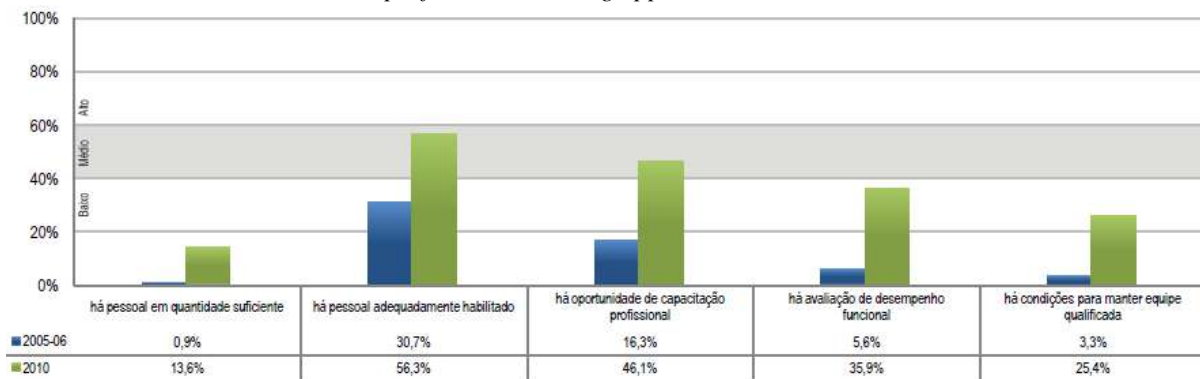
Source: RAPPAM Report 2005/2010 Cycle

Chart 9 – Are there professional training opportunities in federal sustainable use protected areas?



Source: RAPPAM Report 2005/2010 Cycle

Chart 10 – Are there professional training opportunities in the extractive reserves?

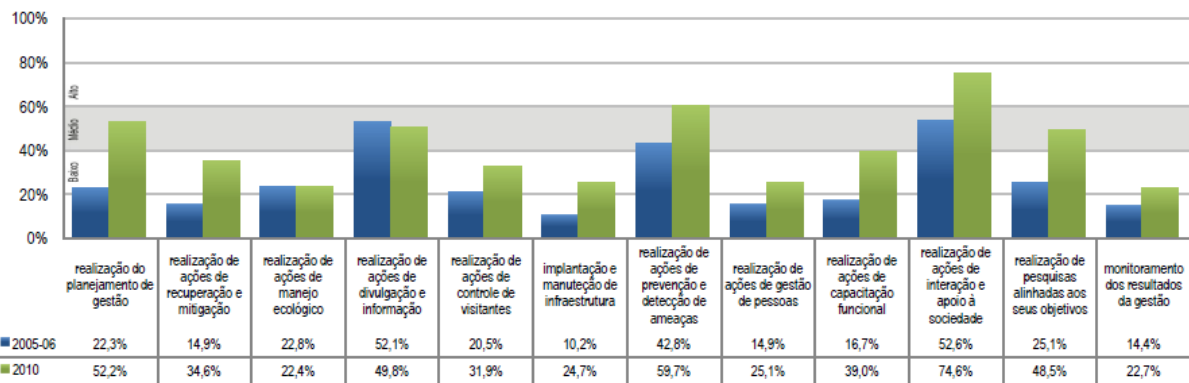


Source: RAPPAM Report 2005/2010 Cycle

The topic "professional training opportunities" aims to show that the professionals working in management bodies of extractive reserves receive preparation through courses, lectures, and workshops. According to Chart 10, training opportunities in 2005/2006 were available in 16.3% of extractive reserves; i.e. very few of the

employees received any kind of training. In 2010 the amount increased to 46.1%; i.e., in that year the topic was average, as defined by RAPPAM (between 40% and 60%); this means that in the course of 5 (five) years there was an increase of 29.8%.

Figure 11 - Results achieved in extractive reserves



Source: RAPPAM Report 2005/2010 Cycle

The RAPPAM 2005/2006 cycles in Chart 11 with regards to "Results achieved in extractive reserves" presented the following indicator: "accomplishment of management actions by people," that is, whether or not those responsible for managing the reserve areas do some kind of work with the community, if there is interaction between residents and the management team. In the years of the above-mentioned result, there was a rate of 14.9%; in 2010 25.1% was obtained, showing an increase of 10.2%. These people's management actions are considered a low rate of management effectiveness according to RAPPAM - less than 40%.

Regarding the "realization of functional training activities," the amount of that item in the years 2005/2006 was 16.7%; in 2010 the percentage was 39% for a total growth of 22.3%. Compared to the item in the preceding paragraph, the functional training activities achieved the best results in the two cycles of application of the RAPPAM method, meaning that the qualifications for employees occurred more frequently in the years cited above than people performing management actions in their own extractive reserves.

Despite this, investment in staff training and development in Exres is unsatisfactory and worrisome, judging by the indices below 40% in Chart 11, indicating a low level of management effectiveness.

The 2014 management plan for ROP EXRES includes the so-called "Management and Administration Program." Under this program there are priority actions such as:

- promote the ongoing training of ICMBio servers, prioritizing issues concerning ROP EXRES.
- seek support for the directors of the associations ASAEX and ASROP with the aim of carrying out basic work on EXRES; for this, logistical, financial, organizational and training support is necessary.

c) ensure improvement in the meetings of the ROP EXRES board promoting cost assistance, in view of the meetings of directors (BRAZIL, 2014, p. 135).

Note that the items that the program brings are of great relevance to meet the CU's needs in relation to staff training and development. Through the priority actions cited above, it is clear that there is concern in equipping ROP EXRES with appropriate infrastructure and human resources, that is, capacitating it for good management.

It is noteworthy that the ROP EXRES management plan makes clear that the training of ICMBio servers will be held on a permanent basis, i.e., the goal is that employees are continuously being trained, which is a positive point for team development.

Another item worth mentioning is the need to provide financial resources to the representatives of the associations so they can participate in board meetings. Board meetings are also ways to develop and empower the team, considering the debates and issues discussed in the meetings.

6.4 QUESTION "D" FROM "MODULE 9 - HUMAN RESOURCES" OF THE RAPPAM METHOD: ARE THERE PERIODIC PERFORMANCE AND PROGRESS EVALUATIONS OF EMPLOYEES?

The evaluation of the single employee Exres follows the pattern of the federal government, in which the employee receives scores from two sources: a) an institutional assessment and b) an individual assessment. The employee is required to make an Individual Work Plan (ITP) with goals and records of all his planned functional actions. The evaluation occurs annually.

The method for evaluating protected area officials' performance is carried out as follows:

a) the employee receives 3 ratings: one issued by their immediate supervisor, one issued by co-workers and one self-evaluation done by the employee himself. The average score obtained from the three ratings is the employee's final score;

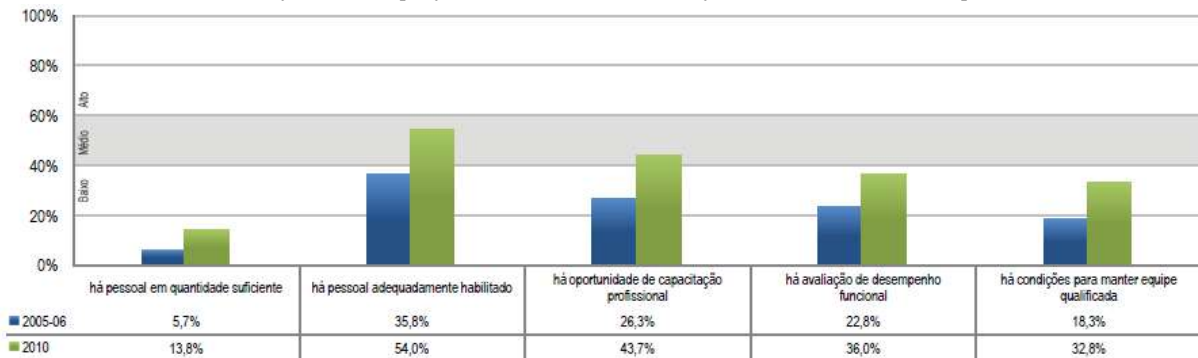
b) the evaluation receives percentage scores. For example, the bylaws of the board mandate that those responsible for protected areas must perform at least two (2) regular meetings per year. In the case that a CU manager holds only one meeting, the score to be allocated is 50% of the total value. If the employee's PTI states that he should issue, "in a timely manner", all SISBIO permits, and he by chance does not meet this goal, delays authorization, or does not give out licenses before the deadline, he gets a score of zero (0) on this evaluation item. Another example are surveillance functions. If the employee is supposed to carry out a minimum of 4 surveillance functions per year, these four will be provided in the system. All data are contained in a digital system; all board meetings have standard proceedings: invitation, attendance, etc.

c) the evaluation consists of 10 items that can be worth a score from 1 to 5. In order for the employee's salary to not be docked, he must achieve a minimum score of 80%.

The management plan does not mention evaluation methods related to employee performance; however, as has been stated, there is a deliberative body that is also responsible for managing ROP EXRES. There is also the participation and support of the two associations ASAEX and ASROP in the case of associations representing the reserve's community, the evaluation takes place by its own representatives and also by the locals. Each one plays a role in assessing whether or not the functions assigned to them are in fact being fulfilled. The management plan proves this through items 31 and 34 recorded in the "Management Agreement" transcribed from the plan.

Through telephone contact with the current chief of ICMBio in the municipality of Guajar Mirim (RO), Mr. Albino Batista Gomes said that ROP EXRES board meetings occur twice a year and should the need arise, extra meetings may also be held.

Chart 12 – Are there functional performance evaluations in federal sustainable use protected areas?

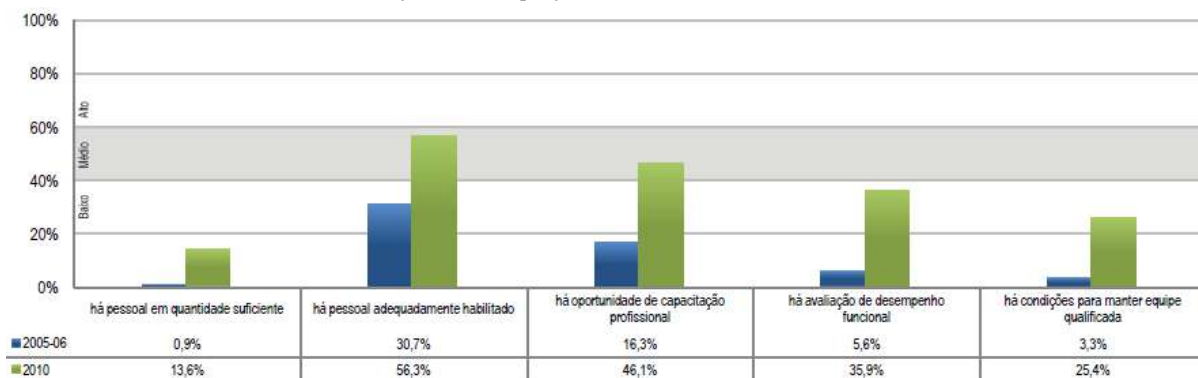


Source: RAPPAM Report 2005/2010 Cycle

With regards to the "functional performance evaluation," Chart 12 shows that in 2005/2006 the percentage was 22.8%; in 2010 the index increased to 36%, resulting in an increase of 13.2%. The highlighted item is interesting, because it shows employee productivity in protected areas, whether they are

performing their activities satisfactorily or not. As might be expected, the low investment in training human resources causes low levels of performance.

Chart 13 – Are there functional performance evaluations in extractive reserves?

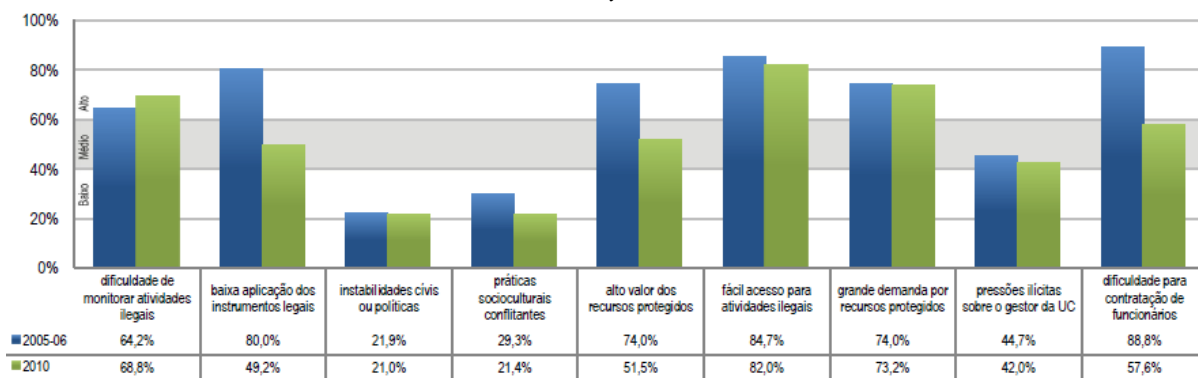


Source: RAPPAM Report 2005/2010 Cycle

Another item worth mentioning in Chart 13 with regards to "functional performance evaluation" is the smallest result of 5.6% in the 2005/2006 cycle. In 2010 the same indicator was evaluated at 35.9%, amounting to

an increase of 30.3%. No doubt this is a topic that had significant advances; however, percentages remain low compared to the average.

Chart 14 - Vulnerability in extractive reserves



Source: RAPPAM Report 2005/2010 Cycle

Regarding vulnerability in the EXRES, Chart 14 points out worrisome figures related to "difficulty in hiring employees." The 2005/2006 cycles' result for this item was 88.8%, meaning that in the period analyzed by RAPPAM the percentage was in the uppermost level, which is in line with the analysis performed earlier about the "amount of staff in CUs "which obtained low rates. This points to a serious failure that compromises the management of protected areas; that is, if governing bodies do not have a large staff, let it at least be satisfactory, in order to meet the needs of extractive reserves.

In 2010 the figure fell to 57.6%, which amounts to a decrease of 31.2% in the periods covered; however, the result is still not satisfactory, because the index indicates a percentage greater than 50% in an area that should have skilled and necessary manual labor workers for all activities related to PAs.

6.5 QUESTION "E" FROM "MODULE 9 - HUMAN RESOURCES" THE RAPPAM METHOD: ARE THE WORKING CONDITIONS SUFFICIENT TO MAINTAIN A TEAM SUITABLE FOR THE OBJECTIVES OF CUs?

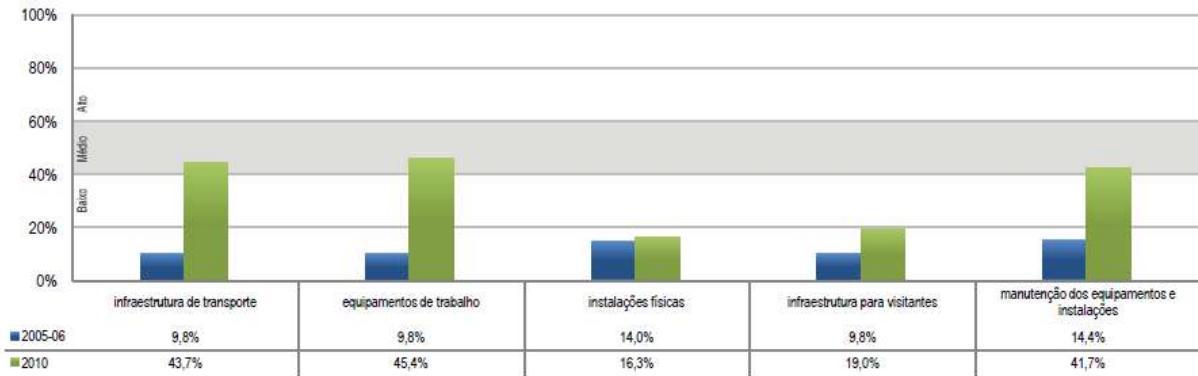
No, the plan indicates that the infrastructure of ROP EXRES does not have conditions suitable for its needs, with only the on-site community within the CU. In the plan, the importance of building a base of support for communities with the ability to save, for example, vessels or other objects is also highlighted.

According to Mr. Albino Batista Gomes, Head of ROP EXRES, the Pompey building is a place where meetings take place with the community and is currently (2019) undergoing renovations. The management plan also draws attention to the need for the associations to have their own offices.

By the time the plan was drawn up in 2014, the ICMBio office was in a rented house, located in the Downtown neighborhood in Guajar-Mirim (RO), urban area of the municipality to which the Exres belongs. Currently, the administrative headquarters are located in

the former building of IBAMA, located at Avenida Dos Seringueiros, No. 1343, district: Liberdade, in the municipality of Guajar-Mirim (RO).

Chart 15 - Infrastructure in extractive reserves



Source: RAPPAM Report 2005/2010 Cycle

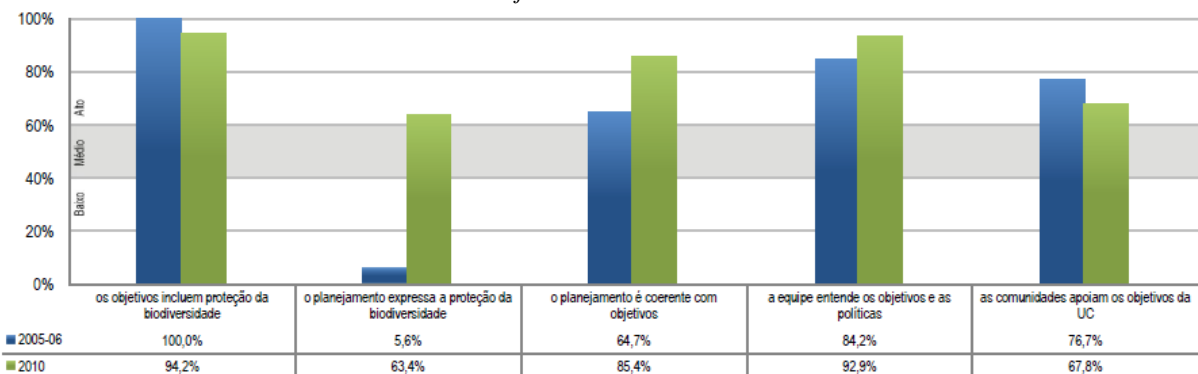
With regards to "transport infrastructure" the application of the RAPPAM evaluation in the years 2005/2006 resulted in a percentage of 9.8%; that is, during this period the locomotion in EXRES was difficult to access due to issues such as lack of fuel, lack of vehicles or small vessels, among other reasons. All these points mentioned led to a low quantitative result in this category. In 2010 the amount increased to 43.7%, an increase of 33.9%.

On "work equipment" the RAPPAM method, as indicated by Chart 15, denotes a rate of 9.8% in the 2005/2006 cycles, indicating that residents along with the management team did not possess the tools necessary to do their jobs. In 2010 the same item increased to 45.4%,

showing a significant increase of 35.6%. This represents a major advance for the above-mentioned topic.

With regard to the item "physical installations" in extractive reserves, that is, structures that adequately meet the needs of the units' residents and managers, Chart 15 shows results with very low rates. According to the 2005/2006 evaluation cycles, the amount was 14% and increased to 16.3% in 2010, representing an increase of only 2.3%. There are difficulties for the EXRES to have adequate physical facilities, and the small increase over the period covered does not represent improvements in this area.

Chart 16 - Objectives in extractive reserves



Source: RAPPAM Report 2005/2010 Cycle

Regarding the topic that addresses whether or not "the team understands the objectives and policies" of extractive reserves, Chart 16 shows positive points in the

above item. The result from the 2005/2006 cycles was 84.2%, a high, satisfactory result from a quantitative point of view. In 2010 the percentage increased even more, to

92.9%, i.e. an increase of 8.7% over the years analyzed. These evaluation data from the RAPPAM method demonstrate a significant and positive step forward for teamwork development in protected areas, namely the fact that teams understand the goals of EXRES and therefore can work towards achieving the purpose of PAs.

VII. IMPORTANCE OF HUMAN RESOURCES IN PROTECTED AREAS

From reading the book *Management of Protected Areas: Sharing a training experience* (2012), we attempted to analyze the importance of human resources in protected areas.

In the chapter entitled *Instruments for Community Participation*, the author Miranda draws attention to the benefits of integrated work, i.e. by means of a more humane and cooperative management system.

On the importance of human resources in protected areas the author states:

Community participation in protected areas arises from the need to improve their management and create alliances with the surrounding communities, partnerships to collaborate in the conservation process of these important areas. Community participation is necessary since the legal requirement is not enough for the country to succeed in the challenge of conservation of natural areas as vast as those found in Brazil (MIRANDA, 2012, p. 240).

It is worth highlighting the role of protected area managers addressed in the book, which are characterized as entrepreneurs, that is, the text points out that a manager is a leader and to this end it takes some initiative to achieve good unit management; one is the ability to listen and understand the needs of the residents. Thus Miranda (2012) says:

(...) the importance of participation of the people in public decisions and policies was recognized, heretofore created exclusively in offices, causing distortions in the initial objectives that often resulted in ignoring local realities. (2012, p. 243)

Based on the knowledge of human resources in protected areas, changes are possible in order to meet the needs of local communities. It is the communities that experience, are familiar with and have empirical knowledge of the reality of the units. Working in cooperation enables efficient management, consisting of exchanges of experiences between the management team and residents of PAs. It is very important to consider the experience of the people in the area, and also discuss relevant issues about the unit with the locals.

The literature concerning the importance of human resources in protected areas is still scarce, which sets up a scenario of little previous research on the topic in question. Thus, the need for scientific studies on the above subject should be noted.

For the management of PAs factors such as adequate infrastructure and skilled personnel are necessary, with particular emphasis on a sufficient number of human resources based on the size of such areas. The role of protected areas will only be fully achieved if the sum of the factors mentioned is in fact implemented in the units, so that they can successfully perform the role of preservation and conservation of biodiversity.

In summary, it can be said that the problems involving CUs are not only reflected in the lack of human resources, but it should also be understood that infrastructure, public agencies and community participation, are points that contribute to the effective management of protected areas. This means that all these issues should be taken into account to address the obstacles faced by PAs.

Regarding the problems faced in protected areas in Brazil:

However, the hiring of qualified personnel alone will probably not solve the problems that conservation areas in Brazil experience, since basic studies in protected areas through partnerships with universities and research institutes are necessary along with a defined infrastructure in each of them, both in terms of human and material resources as well as projects and facilities (HENRY-SILVA, 2005, p. 148).

Efforts to maintain the units are paramount in the process of PA implementation; one can cite as an example the strengthening of management in protected areas, i.e., it is a way to correctly use the protected areas thereby helping to minimize negative environmental impacts in such areas.

Another important factor that should be considered is that the small amount of infrastructure that is installed in the CUs is precarious and low quality. The lack of adequate infrastructure hinders the work carried out in protected areas and also compromises its management. A few examples of actions that are impaired due to lack of the aforementioned factors include: surveillance, monitoring, scientific research, among others. The sum of these factors comes directly or indirectly from a deficiency in infrastructure. The following analysis can also be performed: lack of transportation affects the monitoring and supervision of protected areas. Another important item refers to scientific research for

development. In order to facilitate studies within the units, accommodation for researchers would be viable, since this would facilitate the progress of their work. It would serve as an incentive to contribute directly to the studies that support the improvement of management in protected areas.

Through an analysis of challenges protected areas face, Maganhotto portrays the following scenario:

The great challenge of the units is not in their creation, but in the implementation process, which requires the existence and improvement of different actions such as defining and establishing a management plan, regularization of land as soon as possible, availability of resources humans, implementation of basic infrastructure and achieving financial sustainability, thus minimizing threats to the conservation of resources encountered in the area. (MAGANHOTTO, 2014, p. 216).

No doubt SNUC is an important tool for protected area management in Brazil; it establishes criteria and standards for the creation, implementation and management of protected areas. However, despite the benefits that such a system provides protected areas, the authors note that the guidelines listed in SNUC require implementation so that it can be an effective tool for the conservation of protected areas, in addition to meeting its primary purpose: to protect and preserve nature.

SNUC is weak with regard to support from government agencies that can provide suitable devices for management and preservation of protected areas. Investment is needed in order to meet the system's requirements, so that PAs are able to properly carry out their mission to protect natural resources.

Regarding the lack of human resources, Schiavetti also points out other features that hinder management of these areas:

SNUC represents a public policy meant to strengthen the capacity to plan and properly manage protected areas (PA). However, this protection tool has been criticized due to some deficiencies in implementation and effectiveness for conservation. Among the main problems related to its implementation, the following stand out: undefined land ownership, invasions, lack of human and financial resources and lack of a basis of reliable information about the network of protected areas. (SCHIAVETTI, 2012, p. 612).

A study on CUs carried out in Central Atlantic Forest Ecological Corridor (CCMA) in the State of Bahia, addressed issues such as: management tools, infrastructure, work equipment and land tenure in

protected areas. 48 conservation units at the federal and state level, including those categorized as full protection and sustainable use, were analyzed. With regard to human resources in protected areas, Schiavetti highlights some worrisome data points:

As for human resources, the data indicated that just over half of PAs in the CCMA (56.6%) had three or fewer employees for the performance of various activities, and 13.33% reported having only one manager. (SCHIAVETTI, 2012, p. 617).

One of the points that the lack of human resources directly affects is the inspection of the units that have large territories and few employees in management. Throughout Brazil the status of employees in protected areas is scarce; that is to say that despite the importance of the areas there is no basis for proper monitoring.

Brazil has vast natural resources and it is through protected areas that the preservation of biological diversity is made possible. So the deficiency in the quantity of professionals trained for supervision compromises the purpose of CUs impairs effective management, which also affects local communities. An alternative to this situation would be to conduct public procurement in order to address the shortage of human resources, which could strengthen work teams.

On the supervision of PAs at a national level, Magellan states that:

Studied CUs confirm the national reality as to the unsatisfactory number of human resources in the environmental context, as the country average is just fewer than four monitoring officials per thousand square kilometers. The staff is an important requirement for evaluating implementation because it is directly related to the main objective of these areas: conservation of natural resources, which requires supervision. (MAGALHÃES, 2008 p. 620).

Protected areas require mechanisms that ensure their effective implementation. It should be noted that in order for this to occur, one must first map out the disadvantages of CUs; only then does it become possible to see what needs to be implemented, modified or inserted in the studied scenario.

However, there are items that are directly linked to the management of protected areas; for example: land tenure, staff availability and also working with the communities.

According to Schiavetti, the following items should be considered for effective management of protected areas:

Land tenure regularization, the existence of management tools, hiring managers and the presence of human and financial resources as well as infrastructure, are essential for achieving effective implementation. (SCHIAVETTI, 2012, p. 621).

According to Leite (2015), the RAPPAM method is one of the recurring instruments in evaluating the effectiveness of protected areas; that is, the author points out the relevance of the methodology for this study and its application in protected areas. He further states that through global analysis, the aforementioned method presented five items that represent gaps in the management of the units, namely: human resources, financing, research, community relations and monitoring. Thus, the shortcomings mentioned above indirectly cause problems for protected areas, such as logging, biological invasions and poaching.

By studying the management model of Brazilian PAs, Leite says:

Regarding the current management model and, when considering the existing human resources for protected areas, the monitoring capacity was, in general, insufficient to ensure the effective management of ecosystems. In this sense, the main obstacles identified were related to strategies designed to expand the monitoring capacity and education of the populations located around the protected areas. (LEITE, 2015, p. 125).

The mosaic idea in protected areas constitutes an integrative perspective of various sectors of society. This model proposes integrated, participatory and intersectoral management that makes it possible to work together for the benefit of protected areas, with the aim of achieving better results. The characteristics pertaining to the mosaic idea are beneficial to PAs, since it is based on strengthening management.

There are barriers to the creation and consolidation of mosaics in protected areas; complex projects are needed that can guarantee the involvement of the various public sectors, i.e. it is a field that needs improvements, but there is great strategic potential that drives the issue of mosaics.

According to Melo, human resources contribute to integration processes of protected areas; the author points out:

The asymmetry in the degree of implementation of the conservation units involved and the level of availability of human and financial resources to do so may therefore represent important aspects of the process of integration of protected area management

in a strategic perspective of mosaics. (MELO, 2014, p. 52).

The issue of visitation in protected areas, citing, for example, those related to national parks, involves some essential factors in order to occur in a positive way: one of these factors is the support of human resources. The parks have the function of conservation of biological diversity; however, in that space it is also possible to carry out environmental education, recreation and tourism within nature, i.e. all the items mentioned contribute to the fact that this type of CU fulfill its purpose and strengthen its role.

Regarding the lack of human resources in protected areas, Rodrigues points out some factors that hinder visitation in protected areas:

The lack of human and financial resources is a recurring event in the routine management of protected areas, especially when it comes to implementing and qualifying the infrastructure to support visitation. Thus, depending on the format and the economic feasibility, the consolidation of equipment and infrastructure with funds injected by the concessionaire himself is required. (RODRIGUES, 2013, p. 86).

One of the major problems that directly affects protected areas because of a lack of human resources, are the negative impacts that may happen due to lack of supervision, i.e., the environmental degradation that such areas are subjected to. For proper functioning of the management of protected areas, the organization of responsible public agencies is necessary along with actions to ensure the preservation of natural resources.

Some actions are able to minimize negative impacts within protected areas, including: employee training, environmental education programs and regional development. All these issues will be carried out successfully if the units have appropriate support in the form of human resources for carrying out the work.

According to Pires, a lack of human resources hampers the structure of management of protected areas; the author notes:

Difficulties regarding financial and human resources mean distinct difficulties for the effective implementation of conservation units; moreover, the lack of policies for the management of the units and the disruption of the responsible government agencies pose as a central issue to the degradation of the units. (PIRES, 2015, p. 147).

VIII. MANAGEMENT OF PROTECTED AREAS IN BRAZIL

Based on research conducted on-site at ICMBio, as well as through research publications, participatory projects involving the community in the management of protected areas in Brazil proved important. In this sense, the following examples can be cited:

- a) Cairuçu APA (Rio de Janeiro) through the theater of the oppressed;
- b) The islands and floodplains of Paraná River APA through shared, integrated and participatory management;
- c) Chapada dos veadeiros PARNA (Goiás) and Contagem REBIO (Federal District) through forest restoration, used as a means of environmental education and engagement with communities;
- d) Iguazu PARNA through environmental education as a strategy for strengthening the management of protected areas.

Regarding the aforementioned participatory projects that involve communities:

a) Cairuçu APA:

The Cairuçu conservation unit developed a project called "Theater of the Oppressed," created by ICMBio in the year 2014. Through the project, an environment for dialogue was created between traditional communities and teams responsible for management of the CU.

The goal of the project is to promote the opportunity for discussion and reflection on the interests of communities and issues related to management of the CU. Workshops were held, in which exercises, games and theater techniques were utilized where participants had the opportunity to discuss issues and, with the collective support of the CU management team, to seek possible solutions. The result of the project demonstrated the importance of such initiatives: the traditional communities now have a new perspective on the role of the APA advisory board; there was also more active participation of the community in reviewing the management plan, i.e., it was a stimulus for discussing issues that affect everyone in the APA and should be addressed.

It is noteworthy that the workshops helped not only residents but also the CU management teams. The exchange of information with the population brought a new vision of the role of the institution, staff and Cairuçu APA.

b) Islands and Floodplains APA:

The unit is located in Umuarama (Paraná); it is an area of vast territory, covering 25 (twenty five) counties in three (3) states (Mato Grosso do Sul, São Paulo and Paraná). In order to manage such a comprehensive unit, ICMBio created a management model classified as "Shared, Integrated and Participatory Management (GCIP)." The idea is to engage with local institutions in order to benefit APA management. Partnerships between municipalities, municipal consortia and the APA's management council resulted in many benefits to the CU, such as:

- b.1) Support in preparing the management plan;
- b.2) Greater flexibility in making decisions about issues related to the APA;
- b.3) Decreased costs of infrastructure and human resources.

The management model (GCIP) was important in view of the project ensuring the integration of institutions into APA administration, providing direct contact with the communities, i.e. benefiting management of the CU.

c) Chapada dos veadeiros PARNA and Contagem REBIO:

The forest restoration project arose from the need to prevent the advance of foreign grasses that produce changes in ecosystems, resulting in environmental changes in native vegetation.

The initiative partnered with students at the University of Brasilia and the Brazilian Agricultural Research Corporation (EMBRAPA); research was conducted to find techniques for proper management.

One positive point noted in the course of the project was the involvement of the community in the stages of the study; people helped with everything from collection to planting and monitoring experiments, i.e., they took part in all stages of the project. The community interaction with the process of forest restoration served as a form of environmental education bringing knowledge about the Cerrado directly to management of the CU.

d) Iguazu PARNA:

The Iguazu CU aims to protect species of Brazilian fauna and flora from the Atlantic Forest. The project's goal was to find ways to protect the Iguazu PARNA from hunting pressures, inappropriate land use and water pollution.

The CU is in the vicinity of 14 municipalities. Because of all the threats to biodiversity, the Iguazu PARNA, with the help of public school teachers and technicians from Departments of Education and Environment, offered an environmental education class on protected areas. The main purpose of the course was to show the public that it has a fundamental role in protecting CUs and

simultaneously exposing the value of environmental services provided by the Iguacu PARNA.

Environmental education has contributed to the community's capacity to identify problems affecting the CU, actions that could benefit the protected area and educational processes on these subjects also occurred.

The participatory projects mentioned above made a significant contribution towards helping the management of protected areas. Community involvement provides an atmosphere of exchange of knowledge and ideas; the population has local knowledge, know the reality of the CU in which they live and can contribute to improved management. The management of protected areas is a major challenge, taking into account the territorial dimension, and the cultural, social and environmental diversity they possess.

It is noteworthy that the managers of protected areas are responsible for sensitizing communities to the importance of participating in matters relating to protected areas. Lectures, workshops, and classes, are forms in which the management team interacts with the population. The sum of the collective work makes unit management effective; communities have the opportunity to discuss issues related to CUs, propose alternative solutions, and understand the importance of preserving biodiversity. Managers are also benefited by the local knowledge of the population; in addition, through enabling residents of PAs with environmental education, they become multipliers of this idea and help to monitor protected areas, making up for the lack of human resources in areas of management.

IX. SHARED MANAGEMENT PROGRAM AT GUAJARÁ MIRIM STATE PARK (RONDÔNIA)

The Guajará Mirim State Park (PEGM) is located at the western end of the state of Rondônia, with an area of approximately 258,813 (two hundred fifty-eight thousand, eight hundred and thirteen) hectares; it comprises the municipalities of Buritis, Campo Novo, Guajará Mirim and Nova Mamore. The CU is inserted in an environmental context of great importance because it has a great diversity of plants and animals occurring in different ecosystems and also because it is located in the vicinity of Karipunas, Uru Eu Au Au, and Ribeirão Laje Indigenous Lands as well as Rio Pacaás Novos EXRES.

The shared management program PEGM was developed by the State Department of Environmental Development (SEDAM), with the aim of establishing a participatory structure, i.e., implementing and encouraging environmental education, eco-tourism and

carrying out scientific research. The shared management model was based on beneficial experiences in national parks in Bolivia. In short, the central idea of this model would be to enter into agreements with non-governmental organizations, such organizations being responsible for performing CU management actions, with the support of state and society to assess such actions in advance.

The implementation of shared management at CUs caused some challenges by environmental agencies for the provision of resources for programs; another obstacle has been found relevant to the complexity of rules for bidding which led to the withdrawal of many companies that initially expressed interest in participating in the program.

The participation of the PEGM surrounding residents was essential to achieve positive results in the program, namely, contributing to the maintenance of the conservation unit. Through this union between the management team and the surrounding residents the creation of an advisory board and of park rangers were made possible, the latter being formed by members of the community from nearby locations.

In 2004 the Park was awarded the Amazon Region Protected Area Program (ARPA), and with support from the Brazilian Biodiversity Fund (FUNBIO) achievement of participative management by the park's advisory board was significantly accelerated. Insertion of the State Park in an ARPA program generated other actions for surrounding residents, such as surveys of the surrounding lands, Brigade training, Forest Fire Fighting training, among others.

Shared management of the CU demonstrated the importance of social organization and working together. With social mobilization and contributions from the CU's surrounding residents, the creation of the advisory board was made possible and is a positive point for management of the Park. It should be noted that the commitment and harmonious work of people living around the PEGM along with environmental agencies have provided learning opportunities and constant improvements in management, for the purpose of maintaining and protecting the CU.

Through the example of PEGM mentioned above one can also conceptualize a shared management program for ROP EXRES, i.e. a participatory management model for the unit with support from non-governmental organizations, local communities and environmental agencies.

The ROP EXRES management agreement provides for public participation in matters relating to the CU, and also for contributions from associations and

environmental agencies that are involved in this agreement with explicitly defined rights and duties.

Regarding monitoring of the reserve, the management plan puts forth some measures mentioned in the management agreement, such as:

- a) It is up to the associations and communities to carry out monitoring of the Reserve. It is up to ICMBio to carry out surveillance of the reserve;
- b) Each rubber tapper is responsible for placement and for other settings; he should not only ensure their placement, but also observe that the resources of the Reserve are being watched over by others;
- c) The behavior and actions of visitors in relation to natural resources and improvements in the EXRES are the responsibility of the recipient. Damages that visitors may cause to the EXRES should be reimbursed by those who invited them. (BRAZIL, 2014, p. 111).

It should be noted that the proposal mentioned herein, including work in partnerships of local communities, managers and public agencies in ROP EXRES is a form of CU management aiming towards greater effectiveness for the protection of environmental resources. The benefits of this model are of great importance both for the population and for environmental agencies.

Local communities play a key role in the management of CUs; they can assist in finding environmental problems in protected areas, including: identifying deforestation, supervising other residents of the area and communicating suspected environmental crimes to responsible staff members. Based on the evaluation of the effectiveness of management carried out by the RAPPAM method in the 2005/2006/2010 cycles, ICMBio does not have a sufficient number of servers to supervise the CU, so the support and integration of the population in this sense is of paramount importance for the management of ROP EXRES.

The strengthening of public policies to protect the way of life of traditional populations, the search for improvements in the quality of access to basic services of local communities and also encouraging more young people to enable them to continue developing work within the CU, are ways to manage the unit and thus maintain the conservation of natural resources and improve the quality of life of its beneficiaries.

X. FINAL CONSIDERATIONS

Human resources are essential for the proper management of protected areas in Brazil; despite the lack of a sufficient number of these professionals, this study

demonstrated some ways to mitigate the damage caused by this problem.

One path that has been pointed to is greater community participation in the management of protected areas. Popular contribution helps and is of great importance for the effectiveness of the administration of the areas, given that working together between management agencies and community is a way to meet the real needs of the PA. Residents should be heard by those directly involved in the conservation of protected areas; it is worth noting that the construction of the ROP EXRES management plan, as has been stated, included a large amount of resident participation, i.e., a joint effort with the objective of meeting and understanding what the local population really needs, and seeking improvements in the relevant issues.

Brazil, as a country rich in natural resources, plays an important role in the preservation and conservation of protected areas that are home to much of the globe's biodiversity. Therefore, management should be seen as a priority by both agencies responsible for these areas, as well as the community around protected areas, and society in general. Every individual has a portion to contribute for the sake of effective management in the units. In this regard we note the importance of the ROP EXRES management plan, which points out forms of protection for the unit and also demonstrates ways to ensure that these objectives are met. For example, the governing board, the strategic objectives, programs and sub-programs aimed at environmental conservation, management, enhancement of traditional populations among other ideas listed in the plan.

The RAPPAM method questionnaire, used as the basis for this study, assisted in the development and contextualization of the problem in question. The instrument can be considered an effective way to quickly evaluate the management plans of protected areas. It also serves as a tool for protected area managers, to elucidate the situation of protected areas with regard to various topics, thus allowing for an analysis of what needs to be corrected.

Despite the lack of literature on human resources in protected areas, the authors referred to in this study show the importance of having a greater framework with enough servers available for the size of protected areas in Brazil. This study also showed the importance of further studies on the above topic to contribute to the management of protected areas.

Finally, it is noteworthy that the governing board of the ROP EXRES unit is an important management tool, since despite the low number of servers, the unit operates

in such a way as to fill this gap. The Exres utilizes this board, and this is a positive point for cooperation in protecting the unit.

As a suggestion, this study points to the possibility of shared management being employed in ROP EXRES, similar to other experiences in protected areas, as reported in Section 9 of this text. The alternative can help alleviate much misappropriation of funds caused by the lack of human resources in the reserve. Either way, we must, first, find out whether or not the CU community complies. If all interested and involved parties are in agreement, this option could finally be included in the next update of the management plan.

REFERENCES

- [1] ABNT. Brazilian Association of Technical Standards. NBR 14724: Information and documentation: academic papers: presentation. Rio de Janeiro: ABNT, 2011.
- [2] _____. ISO 10006: Quality management - Guidelines to quality in project management. Rio de Janeiro, 2000.
- [3] BRAZIL. Management evaluation of protected areas: methods RAPPAM (2015) and SAMGE (2016). Brasília: [sn], 2017.
- [4] _____. Best Practices in Protected Areas Management. [S. l.]. [Sn], 2016.
- [5] _____. Management effectiveness of federal conservation units. Comparative assessment of applications Rappam method in federal conservation units in cycles 2005-06 and 2010. Brasília: [s. n.], 2012.
- _____. Instruction No. 01 of 18 September 2007. Discipline Guidelines, Standards and Procedures for the Preparation of Participatory Management Plan of Federal Conservation Unit Categories of Extractive Reserve and Sustainable Development Reserve. Brasília: [sn], 2007.
- [6] _____. No law **9985 of July 18, 2000**. Brasília: [sn], 2000.
- [7] _____. Ministry of the Environment. Brazilian Institute of Environment and Renewable Natural Resources - IBAMA. methodological guide for the elaboration of the management plan of extractive reserves and sustainable development feds. Brasília: [sn], 2006.
- [8] _____. Extractive Reserve Management Plan Rio Ouro Preto / RO. Brasília: [sn], 2014.
- [9] HASSLER. ML The importance of protected areas in Brazil. In: Magazine & Nature Society. 17. ed. Uberlandia: n. 33, 2005.
- [10] HENRY-SILVA. GG The Importance Of Conservation Units On Preservation Of Biological Diversity. São Paulo: LOGOS Magazine, n. 12, 2005.
- [11] MILK. VR analysis of the effectiveness of protected areas for the protection of ecosystems located in fragmented landscapes and under intense anthropogenic pressure in the Atlantic Forest biome. Rio de Janeiro: [sn], 2015.
- [12] MAGANHOTTO; R. F. Protected Areas: limitations and contributions to the conservation of nature. Brasília: [sn], 2014.
- [13] MELO. GM; IRVING. MDA Mosaics of protected areas: challenges for the integrated and participatory management for the conservation of nature. Belo Horizonte: [sn], 2014.
- [14] MEMORIAL CHICO MENDES. Origin of RESEX. Available at: <<http://memorialchicomendes.org/reservesextraction-river-gold-black/>>. Accessed: May 6, 2018.
- [15] MIRANDA. NBG management of protected areas: Sharing a training experience. Tools for community participation. Brasília: [sn], 2012.
- [16] ((O)) ECO. What are protected areas. Available in: http://www.oeco.org.br/dicionario-ambiental/270_99-o-que-sao-unidades-de-conservaçãO/. Accessed: May 6, 2018.
- [17] SAUCER. GF; BUENO. FP Brazilian conservation units: management challenges. [S. l.]. [Sn], 2015.
- [18] REIS, T.; MAGALHÃES. Fiscal JC IBAMA takes care of area equal to 3 cities of São Paulo. In: Off Topic. Available in: <http://www1.folha.uol.com.br/folha/Brazil/ult96u380255.shtml>. Accessed on: 04 out of ten. 2018.
- [19] RODRIGUES, CGO; GODOY, LRC public and private Expertise in management of protected areas: socio-economic aspects of the provision of the visitation support services in national parks. [S. l.]. UFPR, 2013.
- [20] SCHIAVETTI. A. Implementation of the central corridor protected areas of Atlantic forest in the state of Bahia: challenges and limits. São Paulo: [sn], 2012.
- [21] Tachizawa. T. environmental management and corporate social responsibility. São Paulo: High 2011.
- [22] WAWZYNIAK. JV I Report Meeting of Rubber Tappers of the municipality of Guajará-Mirim. Curitiba: IEA, 1989. Mimeo.
- [23] WWF-BRAZIL. Management effectiveness of federal conservation units: comparative evaluation of applications RAPPAM method in federal conservation units in cycles 2005-06 and 2010. Brasília: [sn] 2012.

References in Portuguese

- [1] ABNT. Associação Brasileira de Normas Técnicas. NBR 14724: **Informação e documentação: trabalhos acadêmicos: apresentação**. Rio de Janeiro: ABNT, 2011.
- [2] _____. ISO 10006: **Gestão da qualidade - diretrizes para a qualidade no gerenciamento de projetos**. Rio de Janeiro, 2000.
- [3] BRASIL. **Avaliação da gestão das unidades de conservação: métodos RAPPAM (2015) e SAMGE (2016)**. Brasília: [s. n.], 2017.
- [4] _____. **Boas Práticas na Gestão de Unidades de Conservação**. [S. l.]: [s. n.], 2016.
- [5] _____. **Efetividade de Gestão das unidades de conservação federais**. Avaliação comparada das aplicações do método Rappam nas unidades de conservação federais, nos ciclos 2005-06 e 2010. Brasília: [s. n.], 2012.
- [6] _____. **Instrução Normativa nº 01 de 18 de setembro de 2007**. Disciplina as Diretrizes, Normas e Procedimentos para a Elaboração de Plano de Manejo Participativo de

- Unidade de Conservação Federal das Categorias Reserva Extrativista e Reserva de Desenvolvimento Sustentável. Brasília: [s. n.], 2007.
- [7] _____. **Lei nº 9.985 de 18 de julho de 2000**. Brasília: [s. n.], 2000.
- [8] _____. Ministério do Meio Ambiente. Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais renováveis - IBAMA. **Roteiro metodológico para elaboração do plano de manejo das reservas extrativistas e de desenvolvimento sustentável federais**. Brasília: [s. n.], 2006.
- [9] _____. **Plano de Manejo Reserva Extrativista do Rio Ouro Preto/RO**. Brasília: [s. n.], 2014.
- [10] HASSLER. M. L. A Importância das unidades de conservação no Brasil. In: **Revista Sociedade & Natureza**. 17. ed. Uberlândia: n. 33, 2005.
- [11] HENRY-SILVA. G. G. **A Importância Das Unidades De Conservação Na Preservação Da Diversidade Biológica**. São Paulo: Revista LOGOS, n. 12, 2005.
- [12] LEITE. V. R. **Análise da efetividade de unidades de conservação para proteção de ecossistemas localizados em paisagens fragmentadas e sob intensa pressão antrópica no bioma da mata atlântica**. Rio de Janeiro: [s. n.], 2015.
- [13] MAGANHOTTO. R. F. **Unidades de conservação: limitações e contribuições para a conservação da natureza**. Brasília: [s. n.], 2014.
- [14] MELO. G. M.; IRVING. M. D. A. **Mosaicos de unidades de conservação: desafios para a gestão integrada e participativa para a conservação da natureza**. Belo Horizonte: [s. n.], 2014.
- [15] MEMORIAL CHICO MENDES. **Origem da RESEX**. Disponível em: <<http://memorialchicomendes.org/reserva-extrativista-rio-ouro-preto/>>. Acesso em: 06 maio 2018.
- [16] MIRANDA. N. B. G. **Gestão de unidades de conservação: compartilhando uma experiência de capacitação**. Instrumentos para participação comunitária. Brasília: [s. n.], 2012.
- [17] ((O)) Eco. **O que são Unidades de Conservação**. Disponível em: <http://www.oeco.org.br/dicionario-ambiental/27099-o-que-sao-unidades-de-conservacao/>. Acesso em: 06 maio 2018.
- [18] PIRES. G. F.; BUENO. F. P. **Unidades de conservação brasileiras: desafios da gestão**. [S. l.]: [s. n.], 2015.
- [19] REIS, T.; MAGALHÃES. J. C. Fiscal do IBAMA cuida de área igual a 3 cidades de São Paulo. In: **Folha OnLine**. Disponível em: <http://www1.folha.uol.com.br/folha/brasil/ult96u380255.shtml>. Acesso em: 04 de dez. de 2018.
- [20] RODRIGUES, C. G. O.; GODOY, L. R. C. **Atuação pública e privada na gestão de unidades de conservação: aspectos socioeconômicos da prestação de serviços de apoio à visitação em parques nacionais**. [S. l.]: UFPR, 2013.
- [21] SCHIAVETTI. A. **Implementação das unidades de conservação do corredor central da mata Atlântica no estado da Bahia: desafios e limites**. São Paulo: [s. n.], 2012.
- [22] TACHIZAWA. T. **Gestão ambiental e responsabilidade social corporativa**. São Paulo: Atlas, 2011.
- [23] WAWZYNIAK. J. V. **Relatório do I Encontro dos Seringueiros do Município de Guajará-Mirim**. Curitiba: IEA, 1989. Mimeo.
- [24] WWF-BRASIL. **Efetividade de gestão das unidades de conservação federais: Avaliação comparada das aplicações do método RAPPAM nas unidades de conservação federais, nos ciclos 2005-06 e 2010**. Brasília: [s. n.] 2012.

Recycling Analysis in Northern city in the State of Rio de Janeiro: A Study of Reverse Logistics

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Abstract — *This work analyzes the recycling process of the PET bottle in a company located in Campos dos Goytacazes, - a northern city in the state of Rio de Janeiro, from the concept of reverse logistics. It was sought, through qualitative research with the company to know the process of recycling the PET bottle and its understanding as a contribution to the environmental issue. Visits were made to the company for a period of one month, alternating times during work hours, observing since the arrival of the material collected in the streets until the end of the recycling process, together with the visits carried out was applied a questionnaire with the company's employees in order to measure their understanding of the recycling process. It was developed the process flowchart and the mapping, aiming to allow not only to know the sequence of the process developed, but also to analyze it in terms of strengths and weaknesses. After data collection, it was verified that, with regard to the production process, the employees performed their tasks empirically, knowing only the stage of the process by which they were responsible, and they and the company had no formal procedure to demonstrate the sequential steps involved in the recycling process.*

Keywords — *Reverse Logistics, Recycling, Environmental, PET Bottles.*

I. INTRODUCTION

Industrialization techniques developed in recent years, together with the increase in population and consumption, factors that have caused the rise of global demand, with consequent increase in the amount of post-consumption disposal, hampering its final destination. In this context, recycling arises not only as an ecological flag, but also as a real option for industry and society, combining ecological awareness with economic and technological Development (BALLOU, 1993; ANDERSON & NARUS, 1990).

The logistics of return flows or reverse logistics is aimed at the efficient execution of product recovery. Reverse logistics has as its purpose the reduction, disposition and management of toxic and non-toxic waste. Although it is easy to think of logistics such as managing the product flow from the acquisition points to the customers, for many companies there is a reverse logistic channel that must be managed as well. The life of a

product, from a logistic standpoint, does not end with its delivery to the client (BALLOU, 2006; ARBACHE, 2004).

The needs of reverse logistics also stem from the growing number of laws prohibiting indiscriminate disposal and encourage the recycling of beverage containers and packaging materials, which also emphasize that the most significant aspect of logistics reverse is the need for maximum control when there is a possible responsibility for damage to health. In this sense, a market withdrawal program is similar to a maximum customer service strategy, which must be executed independently of the cost (Bowersox & CLOSS, 2001).

Together with the recycling process, studies have been carried out on the Life Cycle Analysis of the PET bottle (ethylene Polyterephthalate), from the extraction of the raw material to the final destination, in order to better know the product and its influence on The Environment (ABEPET, 2009; OLIVEIRA, CANDIDO, 2009).

This work aims to evaluate the Productive Chair of the reverse logistics of PET (ethylene Polyterephthalate), verifying the stages of the recycling process, being necessary for this a bibliographical survey and a case study in the organization searched. The objective is also to form a specific knowledge base on the subject, absorbing the theoretical knowledge and adapting the practice.

II. LOGISTICS IN BRAZIL

Logistics is the area of administration that takes care of the transportation and storage of goods. It is the set of: planning, operation and control of the efficient and effective flow of materials, services and information of the company, integrating and rationalizing the systemic functions, from production to delivery, ensuring competitive advantages in the chain of Distribution and, consequently, clients satisfaction (CHING, 1999).

The word logistics comes from the French "Logistic", which derives from "Loger" (place, lodge, inhabit). This term originally meant transportation, supply and troop accommodation. It is related to the word "lodge" (which is an older word in english, but has the same latin origin). "Logistics" appeared in the english language for the first time in the 17th century. It is noteworthy that logistics is not related to the logistic mathematical function (BALLOU, 2006; LUMUS, 1999).

The new requirements for logistics activity in Brazil and in the world go through greater control and identification of opportunities to reduce costs, reduce delivery times and increase quality in compliance with the deadline, constant availability of products, scheduling of deliveries, ease in order management and manufacturing easing, long-term analysis with increments in technological innovation, new costing methodologies, new tools for redefinition of processes and adequacy of

business (CHRISTOPHER, 1997; FIGUEIREDO & ARKADER, 1998).

III. REVERSE LOGISTIC

In the 80 years, the concept of reverse logistics was still limited to a movement contrary to the direct flow of products in the supply chain. It was in the decade of 90 that new approaches were introduced and the concept evolved driven by increased concern about environmental preservation issues. This pressure, induced by consumers, implied legal actions of the supervisory organs. In addition, from this period, the processing and distribution companies began to see reverse logistics as an important source of loss reduction. In this way, the reverse logistics activities began to be used in greater intensity in the United States and Europe, countries where the concepts and classical tools of logistics were already more widespread (BARRATT, 2004; FLEYRY, 1999).

Therefore, reverse logistics as the area of business logistics that plans, operates and controls the flow and the corresponding logistical information, the return of after sales goods and post-consumption to the business cycle or production cycle, through the channels of reverses distribution, adding value of several natures: economic, ecological, legal, logistic, corporate image, among others (LUMUS, 1999; GRIMAS, 2010).

The analysis of products and materials has the function of defining its state and determining the process to which it should submit. Figure 1 shows, in a simplified way, the operation of the reverse logistic process (LACERDA, 2009; TERPENE, 2008).

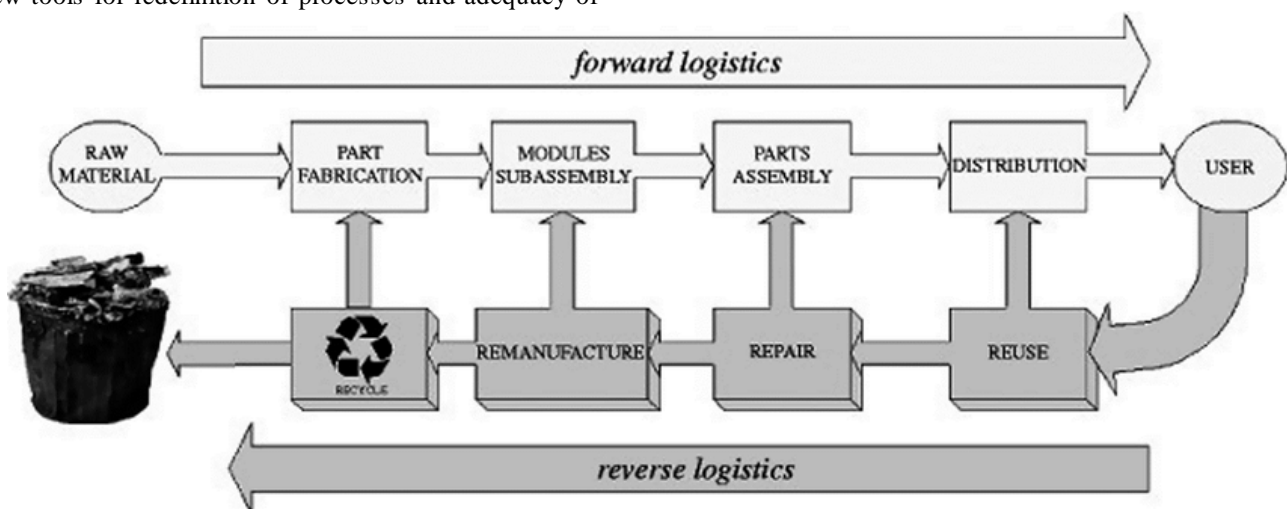


Fig. 1: Schematic illustration of logistics and reverse logistics.

Source: Adapted from Lacerda, 2003.

Figure 2 emphasizes how the reverse channel can add value to the logistic system. It is observed that the reverse logistics of after sales, in conjunction with the post-consumption, provides benefits to the corporate image,

competitiveness and cost reduction of the company (LEITE, 2003; LAMBERT, 2009).

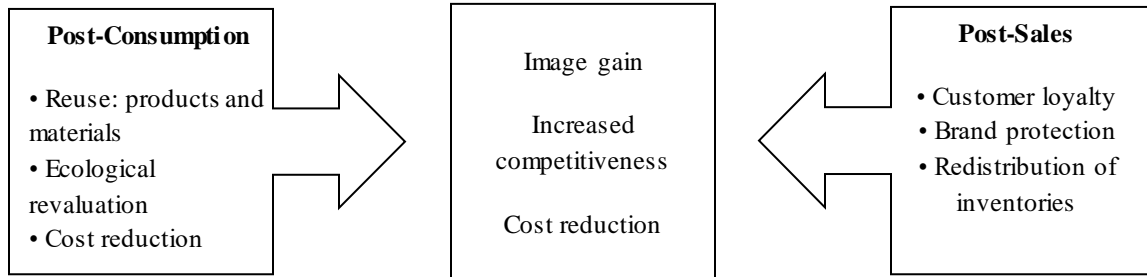


Fig. 2: Reverses Streams: adding value.
 Source: Adapted from Leite, 2003.

According to Leite (2003), the reverse after sale distribution channel characterizes the return of product that presented problems. For this same author, the strategic objective is to add value to a logistic product that is returned for commercial reasons, errors in the processing of orders, guarantee given by the manufacturer, defects or failures of operation, faults in transportation, among other things. This return flow will be established between the various links in the direct distribution chain, depending on the strategic objective or the reason for the return. The distribution channel of post-consumer reverse logistics is characterized by products discarded by society in general that return to the business cycle or to the productive cycle through the specific

reverse distribution channels (WHIPDLE, FRANKEL, DAUGHERTY, 2002, VOSS, TSIKRIKTSIS, FROHLICH, 2002).

Reverse logistics operates in two large areas, differentiated by the stage or phase of the life cycle of the returned product (LEITE, 2004). This research highlights the concepts of reverse logistics of post-consumption (Figure 3), called as an area of logistics that equally equates and operationalizes the physical flow and information. Correspond to the post-consumer goods discarded by the society, which return to the business cycle or to the productive cycle by the specific reverses channels (MAYLETT & VITASEK, 2007, SANDBERG, 2007, SIMATUPANG, DHARAN, 2002).

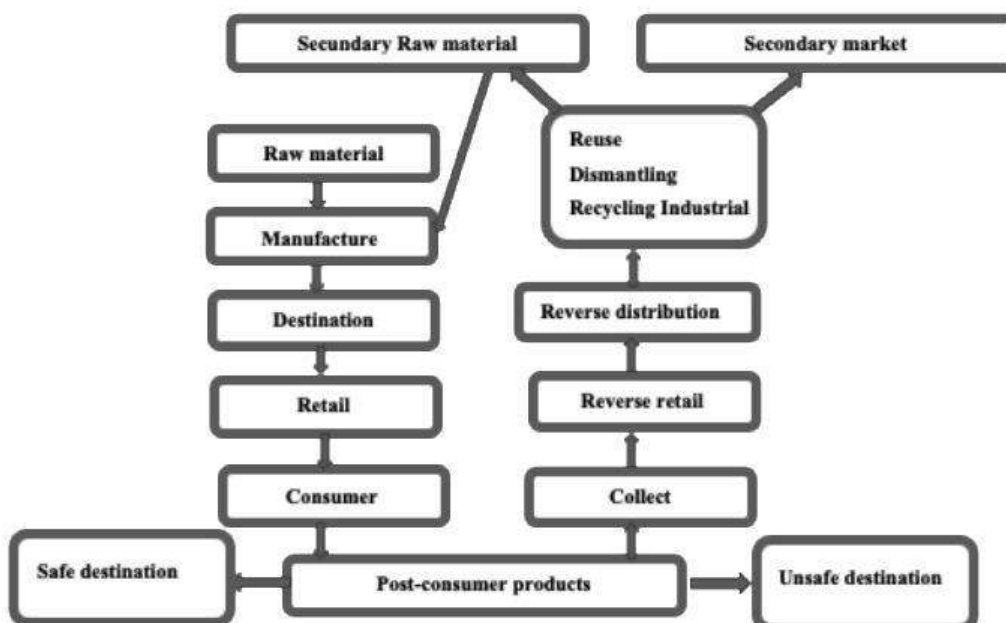


Fig. 3: Post-consumption Reverse Logistics Flowchart.

Source: Adapted from Leite, 2003..

In the conception of Leite (2009), these goods or materials are transformed into products called post-consumption and may be sent to traditional final destinations such as incineration or landfill, considered as safe means of storage and disposal, or return to the productive cycle through dismantling, recycling or reuse channels in an extension of its useful life. These alternatives to return to the productive cycle constitute the main concern of the study of reverse logistics and post-consumer reverse distribution channels.

IV. RECYCLING AS A STRATEGY FOR REVERSE LOGISTIC

The preoccupation with recycling emerged in the meaty of the decade of 80, when it was disclosed that non-renewable raw materials, such as oil and space for storage of garbage were running out (LEITE, 2004; ABIPET, 2009).

The word comes from the English recycle (re = repeat and cycle), where: Recycle and reuse assumes different meanings: reuse would transform the industrialized product into an equal product, and recycling is the act of reusing materials for a new Product (LEITE, 2004; OPENS, 2004).

Recycling is another area of the economy that suffers from the global crisis. Consumption decline production industries in large centers productive and demand reduction recycled materials worldwide economic effect.

The situation demonstrates the increasing need to improve the recycling infrastructure in the country. Efficient collection materials greater value can obtain internal and external market. (LEITE, 2010; MORASH, CORNELHA, SHAWNEEE, 1999).

Polyethylene terephthalate, PET, was synthesized in 1941 by ICI (Imperial Chemical Industries), being very used in the manufacture of synthetic fibers for the textile industry. In Brazil, only in 1989 began the production of the PET bottle (Leite, 2003:196).

In Brazil as most recycling companies are small and manpower is cheap, the separation is done mainly in a manual way. The separation of polymers can be made by identifying the symbology contained in the finished product and/or the use of simple tests, such as the odor of burning vapors, flame appearance, melting temperature and solubility, which are based on their physical characteristics and thermal degradation, which are distinct (NOVAES, 2007). In addition, polymers are used to manufacture several finished products; However, some of them can only be produced from a specific type of polymer, such as carbonated beverage packages that are manufactured from PET, thus facilitating their identification and separation of polymeric residue (SPINACE, 2005; CEMPRE 2009), as shown in Figure 4.

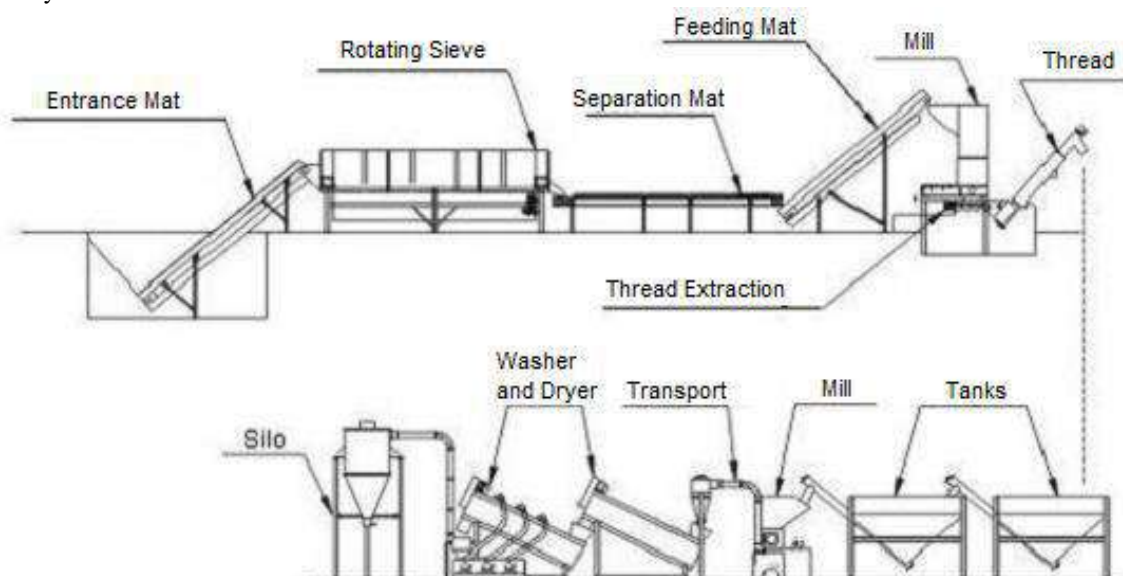


Fig. 4: Recycle Cycle.

Source: Spinace, 2005.

It is also possible to formulate post-consumer polymers by adding small amounts of virgin material in

order to improve the properties of recycled polymers. After formulation, the polymer can be reprocessed and finally obtained a new artifact (SPINACE, 2005).

Through the quality tool, which are techniques used for the purpose of defining, measuring, analyzing and proposing solutions to the problems that interfere in the good performance of the work processes was chosen the flowchart.

The Company under study RGC Recycling – ME, which operates in the recycling area of the Pet Bottle in the city of Campos dos Goytacazes, is located at street F, number 15 in Parque Codin. Founded by Robson Gomes Barbosa 1982, working market present day.



Fig. 5: Photo of the company RCG-RECICLAGEM-ME

Source: Own.

In these years of business, the owner has been investing in the lacks the establishment, providing improvements in working conditions, equipment, the recycling sector and the decantation. With this, providing satisfaction to employees and customers.

As can be seen the company is growing increasingly, because it is always searching new ways to innovate and increase its revenues. It is also noted that the company has a high sales potential, but these factors are not sufficient to ensure success, because the company has a number of problems that need to be solved for the welfare of all. In Figure 5 shows the front of the company under study, RGC-RECYCLING ME.

V. ANALYSIS OF REVERSE LOGISTIC IN THE RECYCLING SECTOR

According to Villela (2000), the process mapping is an analytical and communication management tool essential for leaders and innovative organizations that intend to promote improvements or implement a structure geared to new processes. The process mapping becomes important for companies because it allows understand how processes work, their components, besides facilitating the analysis of their effectiveness and locating their deficiencies. Figure 6 shows the Process Mapping developed for the RGC Company.

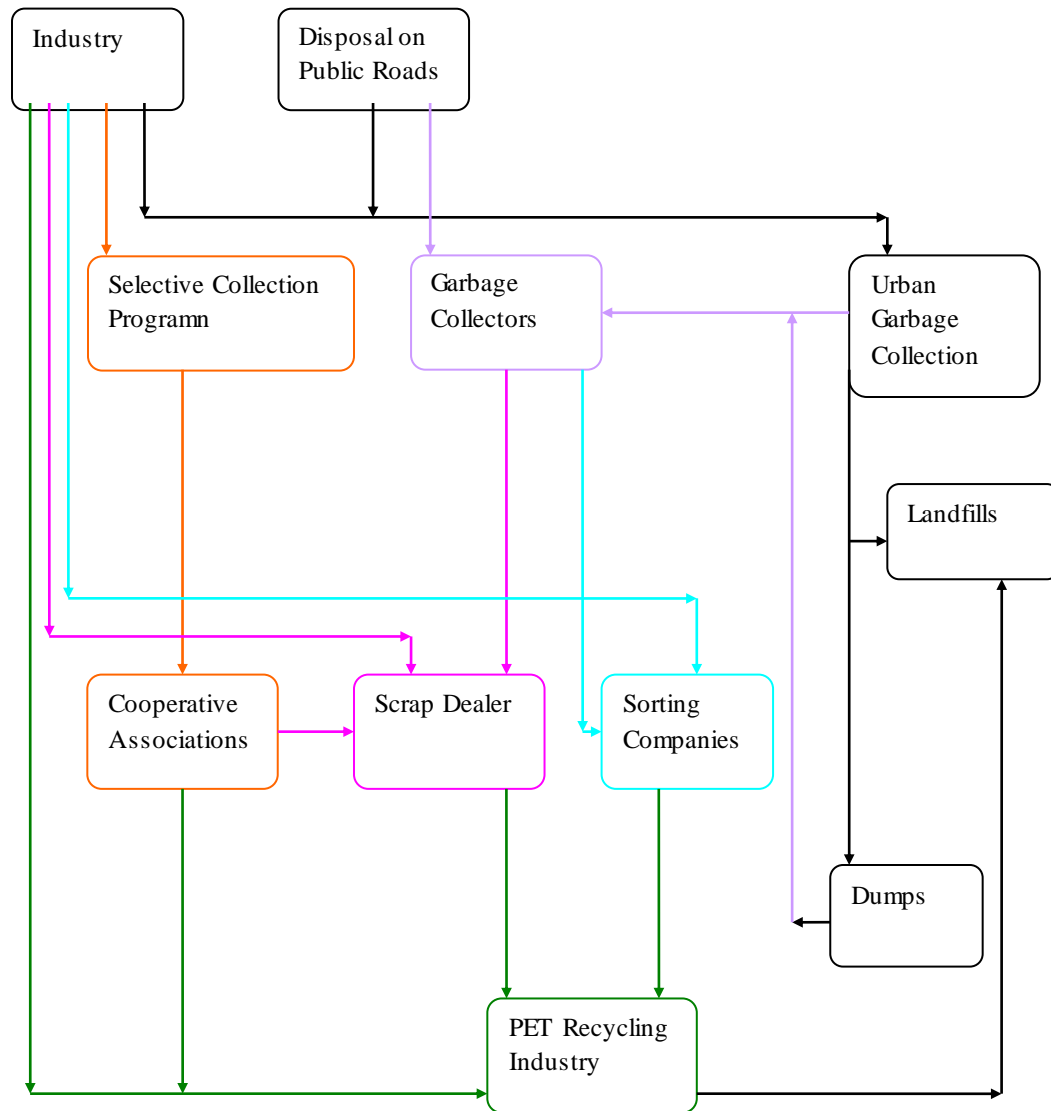


Fig. 6: Mapping the PET Recycling Process of the company RGC.
Source: Own.

In addition to the process mapping, the flowchart was developed for the company under study. The purpose of the flowchart was to highlight the sequence of the work developed. The steps in the flowchart can be seen in Figure 7.



1. Transportation bringing to the company the garbage for the recycling process



2. Product control scale



3. Process of separation by type and color



4. Pressing process



5. Grinding and rinsing process



6. Drying process



7. Drying process passing through the air tube



8. The flakes already dry and ready to be packed



9. Semi-finished product

Fig. 7: Steps of the recycling process of the PET bottle.

Source: Own.

From the process mapping and the analysis of the work stages, a flowchart was constituted to analyze the processes from the collection to the semi-finished product, as shown in Figure 8.

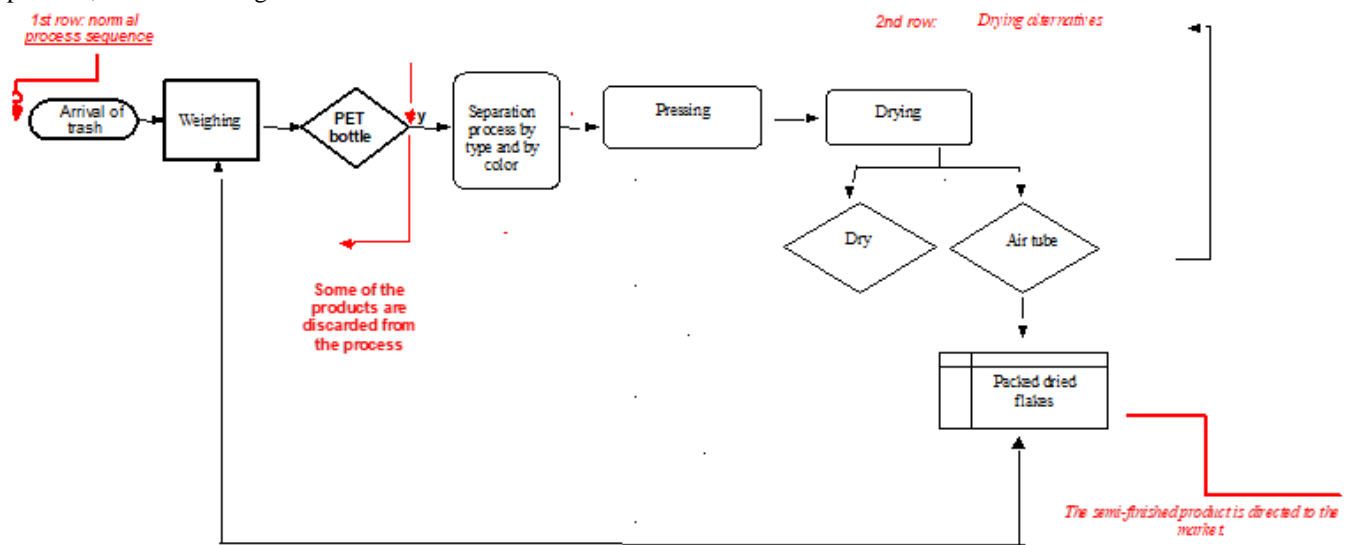


Fig. 8: Flow chart of PET bottle recycling process

Source: Own.

VI CONCLUSION

This work showed the recycling process of the PET bottle in a company in the northern city in the state of Rio de Janeiro, Campos dos Goytacazes. It revealed that the company is aware of the importance of reverse logistics for the country, society and the environment.

Through the application of the questionnaires to the manager and also to the employees, it was identified that the company has no. The mapping of processes allied to the costing by activities can contribute to a method to describe its production process. On the contrary, it follows the trend of most companies that rely on folders filled with procedures and instructions that don't really reflect how the company works and does not lead to identification of improvements.

The process flowchart and mapping were developed to provide subsidies for a better quality in the performance

of the recycling process. It was considered that a more rational operational planning contributes to greater organizational efficiency and identification of opportunities for improvement. Thus it was proposed the development of process mapping to be used with a tool of deep evaluation of the business object, allowing processes to be modified, canceling or redesigning. The Flowchart was developed considering it to be a visual tool that allows a detailed understanding of the parts of the process in which some type of flow occurs.

REFERENCES

- [1] ABEPET-Brazilian Association of PET Packaging Manufacturers (Online). Available from: <<http://www.abepet.com.br>> Access on: August 16, 2009.
- [2] ABIPET. Brazilian Association of the PET Industry. Corporate Website (Online) Available at: <www.bipet.org.br>. Accessed on: 01 September 2009.

- [3] ABRE-Brazilian Packaging Association, 2004 (Online). Available from: <www.abre.org.br> Accessed on: 26 October 2009
- [4] ANDERSON, J. C.; NARUS, J. A. A model of distributor firm and manufacturer firm working partnerships. *Journal of Marketing*, v. 54, n. 1, p. 42-58, 1990.
- [5] ARBACHE, F. S. et al. *logistics, distribution and trade marketing Management*. Rio de Janeiro: FGV, 2004.
- [6] BALLOU, R.H. *business Logistics: Transportation, materials management and physical distribution*. São Paulo: Atlas, 1993.
- [7] _____. *Supply Chain Management/business logistics; Translation Raul Rubenich*. 5. ed. Porto Alegre: Bookman, 2006
- [8] BARRATT, M. Understanding the meaning of collaboration in the supply chain. *Supply Chain Management: at International Journal*, v. 9, n. 1, p. 30-42, 2004
- [9] BOWERSOX, D. J.; CLOSS, D. J. *Business Logistics*. São Paulo: Atlas, 2001.
- [10] CEMPRE – Business Commitment to Recycling. PET Recycling in Brazil. Available from: www.scielo.br Access: On 15 September 2009.
- [11] CHING, Hong Yuh. *Inventory Management in the integrated logistics chain*. São Paulo: Atlas, 1999.
- [12] CHRISTOPHER, Martin. *Supply chain Logistics and management: strategies for reducing costs and improving services*. São Paulo: Pioneer Thomson Learning, 2002.
- [13] _____. *Logistics and Supply Chain Management: Strategies to reduce costs and improve services*. São Paulo: Pioneer, 1997.
- [14] FIGUEIREDO, K. F.; ARKADER, R... "From the physical distribution to Supply Chain Management: The thought, the teaching and the needs of logistics training". *Technologic Magazine*, São Paulo, 1998.
- [15] FLEURY, P. F. *Supply chain management: conceitos, oportunidades e desafios de implementação*. *Technologist*, n.39, fev.1999.
- [16] GRIMAS, Washington. *Flowcharts*. Available from: <<http://engenhariasomarcos.files.wordpress.com/2008/03/fluxogramas1.pdf>> Access on: April 13, 2010.
- [17] LACERDA, Leonardo. *Reverse Logistics, a vision of basic concepts and operational practices*. Center for Logistics Studies-COPPEAD-UFRJ-2202. Online Available from: <www.cel.coppead.ufrj.br> Access on: 08 October 2009.
- [18] LAMBERT. *Fundamentals of Logistics Management*. Columbus, McGraw-Hill, 1993. Disponível em: <www.scielo.br> Acesso em: 25 de Outubro de 2009.
- [19] LEITE, Paulo Roberto. *Reverse Logistics-Environment and competitiveness*. Sao Paulo: Prentice Hall, 2003. _____. *Reverse Logistics – Panorama 2004*. *Technologic Magazine*, May 2004.
- [20] LEITE, Paulo R. and BRITO, Eliane Z.. *Reverse Logistics of Products not consumed: a description of the practices of companies working in Brazil*. SIMPOI 2003 Congress. Accessed on: August 19, 2009.
- [21] LUMMUS, R. R., VOKURKA, R. J. Managing the demand chain through managing the information flow: capturing “moments of information”. *Production and Inventory Management Journal*, First Quarter, 1999.
- [22] MAYLETT, T.; VITASEK, K. For closer collaboration, try education. *Supply Chain Management Review*, v. 11, n. 1, p. 58, 2007.
- [23] MEIRELES, Nino Ricardo, 2008. *Business Logistics*. Accessed: September 18, 2009
- [24] MORASH, E. A.; CORNELIA, L. M. D.; SHAWNEE, K. V. Strategic logistics capabilities for competitive advantage and firm success. *Journal of Business Logistics*, v. 17, n. 1, p. 1-21, 1996.
- [25] NOVAES, A.G. *Logistics and distribution chain management*. 3. ed. São Paulo: Elsevier, 2007.
- [26] OLIVEIRA, D.P. *Systems, organization and methods: a managerial approach*. 11. ed. São Paulo: Atlas, 2001.
- [27] OLIVEIRA, Veronica M.; CÂNDIDO, Gesinaldo A. *Logistic Management: The case of a food industry*. In: NATIONAL MEETING OF PRODUCTION ENGINEERING, 26 °, 2006, Fortaleza. Available at: <[Http://www.abepro.org.br/biblioteca/enegep2006_tr45030_2_7010.pdf](http://www.abepro.org.br/biblioteca/enegep2006_tr45030_2_7010.pdf)>. Access on: 06. June 2009.
- [28] SANDBERG, E. *Logistics collaboration in supply chains: practice vs. theory*. *International Journal of Logistics Management*, v. 18, n. 2, p. 274-293, 2007.
- [29] SIMATUPANG, T. M.; SRIDHARAN, R. The collaborative supply chain. *International Journal of Logistics Management*, v. 3, n. 1, p. 15-30, 2002.
- [30] SPINACÉ, M. A. S; PAOLI, M. *Polymer Recycling Technology*. *New Chemistry*, v. 28, 2005. Available from: <http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0100-40422005000100014>. Accessed on: October 28, 2009.
- [31] TERPEND, R. et al. Buyer-supplier relationships: derived value over two decades. *Journal of Supply Chain Management*, v. 44, n. 2, p. 28-55, 2008.
- [32] VILLELA, C. S. S. (2000)-*Process Mapping as a Tool for Restructuring and Organizational Learning*, Dissertation of M.Sc. PPEP/UFSC, Florianópolis, SC, Brazil.
- [33] VOSS, C.; TSIKRIKTSIS, N.; FROHLICH, M. Case Research in Operations Management. *International Journal of Operations & Production Management*, v. 22, n. 2, p. 195-219, 2002.
- [34] WHIPPLE, J. M.; FRANKEL, R.; DAUGHERTY, P. Information support for alliances: performance implications. *Journal of Business Logistics*, v. 23, n. 2, p. 67-82, 2002.

Reverse Logistics Applied to the Sustainable Management of Post-Consumer Cement Packaging

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Abstract — One of the main global challenges is developing methods for the sustainable destination of non-recycling wastes. In this study, a sustainable treatment and destination for post-consumer cement packaging through analyses of its potential as an alternative fuel in cement production and the evaluation of the use of reverse logistics as a tool for the management of this waste were carried out. A methodology was adopted through bibliographic research, laboratorial evaluation of cement bags and case study of reverse logistics in a large Brazilian cement company that uses co-processing. The results proved, through laboratory analyses, the suitability of the post-consumer cement packages for use as alternative fuel in clinker kilns. The viability was proven through the use of the reverse logistics tool as a management model, using facilitating levers such as return freight and collected packing volumes. The results of these experiments can provide a basis for cement companies, especially in South America, to use similar methods to ensure the final reverse logistics of their waste.

Keywords — Cement industry; Reverse logistic; Waste management.

I. INTRODUCTION

It can be said that in the absence of alternatives and new technologies aimed at reducing the life cycle of products, consequently, there is a significant increase of the discard. In this scenario, some companies have sought to focus their sustainability strategies on the impacts generated in after-sales and post-consumption activities. In Brazil, after the adoption of more restrictive legislation regarding the final disposal of products at the end of their useful life, some companies have adopted the return of their products from final consumers, aiming at a possible reuse, recycling in their production cycle or in others cycles, or even to the final disposal [1-4].

In Brazil, the National Solid Waste Policy (NSWP) defined the mandatory waste that must undergo a process of structuring and implementing a reverse logistics system: I-agrochemicals, waste and packaging; II-batteries and accumulators; III-tires; IV-lubricating oils, their residues and packaging; V-fluorescent, sodium and mercury vapour lamps and mixed lamps; VI-electrical and electronic products and their components.

The NSWP defines reverse logistics as an instrument of economic and social development characterised by a set of actions, procedures and means to enable the collection and restitution of solid waste to the business sector, for reuse, in its cycle, other productive cycles or

another environmentally appropriate final destination [5-6].

Rogers and Tibben-Lembke [7] define reverse logistics as the process of planning, implementing and controlling the flow of raw materials, in-process and finished products and information, from the final consumer to the supplier, in order to recover value or make an appropriate environmental disposition.

In Brazil, cement packaging does not fall under the list of wastes with the obligation to be treated by the reverse logistics process [5]; however, the responsibility for the life cycle of the products is established in the National Solid Waste Policy, and there must be a commitment on the part of the government, companies and society on the final disposal of waste.

In the specific case of cement, after its use in the works in general, the cement packages torn and/or impregnated of the cement itself are not collected by the collectors (social organisations of urban waste collection) and end, directly or indirectly, in the final disposal of public waste.

Cement is characterised as the base and main component of concrete, which is the most consumed product in the world. Brazil is among the 10 largest cement producing countries in the world, with its internal cement production exceeding 70 million tons, being

consumed practically in all residential, commercial or major infrastructure works.

Correct cement storage is essential to prevent losses and changes in product characteristics. Multi-sheet kraft paper bags are used as the packaging suitable for transport and for quick application. The paper bags meet the requirements of the production flow of the bagging machines, which is the only one that allows filling with the still very heated material coming from the production process.

The practice of reverse logistics in order to recycle or reuse the post-consumer packages may present some bottlenecks due to the presence of cement or even other contaminants in these packages, making it unfeasible for reuse in the manufacture paper and cardboard due to the high removal costs of contaminants and industrial processing.

In its production process, the cement industry has an inherent need for fuel with high heat of combustion. Thus, the sector is positioned with an alternative to the disposal of solid waste with high calorific value, as they are desirable as fuel for thermal processes in the cement industry [8]. Thus, it becomes an activity of interest, both for society to ensure an environmentally correct destination and for the cement industry for its economic gains. However, environmental viability must be evaluated objectively, systematically and holistically.

The main focus of this article is to present the reverse logistics applied to post-consumer cement bags recovered in buildings under construction, considering that contaminations of these garages prevent or are not attractive to use as a raw material (pulp) in the manufacture of paper and cardboard.

The company's main activity is the manufacture of four types of cements; it is located near the raw materials (limestone and silica) and is at a distance of about 200 km from the sale of cement bags and 150 km of recycling companies that supply fuels from industrial waste.

II. CEMENTS INDUSTRIES

The cement industries are considered specific when it comes to the need for thermal energy, since the process needs to reach high temperatures. Usually, fossil fuels such as coal, fuel oil and petroleum coke are used and generate large amounts of carbon dioxide (CO₂) into the environment. Considering that the raw material is limestone (CaCO₃) and the sources of energy are fossil fuels it is almost impossible to change this matrix. Co-processing in the cement industry is a thermal waste destruction technique in which the thermal energy generated by the combustion of these materials is used in

the clinker manufacturing process, maintaining the quality of production in accordance with the standards and without altering the quality of the cement produced. The use of organic wastes from agriculture (sugar cane bagasse, rice straw) and petroleum/petrochemical industry waste, papers, plastics, paints and tires is common. In this process, the wastes are initially pre-processed and transformed into a mix of alternative fuels, in order to be injected into the production process in high-temperature areas, partially replacing traditional fuels. However, the cement industry must always be aware of the origin of the waste and guarantee the final quality of the alternative fuel mix, in order to avoid any changes to the environment and the quality of the cement produced [9].

The waste is injected in the rotary kiln at temperatures of 1200 °C and 2000 °C. The high temperatures associated with the residence time of approximately 30 minutes for solid materials and 3 seconds for gases, suitable oxygenation conditions, high turbulence, alkaline environment, exchange of heat between the flue gases and the raw material can guarantee the destruction of practically all organic compounds, neutralisation and adsorption of some contaminants and the incorporation of the ashes of the inorganic compounds into the clinker, without impairing the quality of the fabricated cement [10-12]. Before such waste is placed in clinker kilns (the main raw material for cement), there are pre-treatments to ensure that the characteristics of the waste remain constant and do not cause adverse effects to the cement produced or to the environment [13].

According to Galvez-Martos and Schoenberger [14], the United States achieves an average of 11% thermal replacement of fuel by cement production, while Europe achieves an average of 28% replacement. Among the member states of the European Union, however, replacement rates are very different, ranging from less than 5% to more than 80%. For example, in Austria the current replacement rate is 46%, 61% in Germany and 83% in the Netherlands. In these countries waste co-processing is well implemented and, therefore, the manufacture of clinker can play an important role in national and international waste policies.

In Brazil, the first practice began in the 1990s, having been nationally regulated in 1999 by CONAMA Resolution 264[15]. The Brazilian cement park consists of 102 units, 60 of which are integrated with rotary kilns, predominantly in the Southeast and Northeast, where 37 of these units are licensed for co-processing. The processed waste represented the elimination of an environmental liability of 1.12 million tons. Of this amount, 20% of the waste was used as substitutes for the

raw materials and the remaining 80% as alternative fuels. The rate of thermal replacement in that year due to the use of alternative fuels reached 8.1% [16,17].

III. PROPOSED REVERSE LOGISTICS APPLIED TO THE CIMENTAL INDUSTRY

The concept and execution of reverse logistics have existed in companies since the beginning of capitalism but have been restricted to two forms: either through products that have suffered some kind of process error, return damage without being consumed or have reached market obsolescence, known as aftermarket reverse logistics or those post-consumer, which have fulfilled their useful life but remain as usable waste. In this last form, there are two types of products: those residues that have important added value and, therefore, are returned by the market without much difficulty, such as metals, engine parts and medical equipment and those that do not return, since their waste products do not have sufficient added value and do not yet require development to make return logistics attractive. This is the typical case of plastics, Tetra Pak packaging and debris [18].

According to Govindan et al.[19], reverse logistics starts with end users (first customers), where used products are collected from customers (return products), and attempts to manage end-of-life products through different process including recycling (to have more raw materials or raw parts) remanufacturing (to have them sold to the second markets or, if possible, to the first customers), repair (to sell in the second markets through repairs), and finally, disposal of some used parts.

Reverse logistics can be defined as the part of logistics that aims to relate topics such as: reduction; conservation of the source; recycling; replacement; and disposal of traditional logistics activities, such as supplies, traffic, transportation, storage.

In Brazil, among the National Solid Waste Policy determine the importance of shared responsibility for the product life cycle and reverse logistics [5].

Considering the assumptions presented previously, the reverse logistics applied to the evaluated cement plant is centred on the following points (Figure 1):

- Laboratory analysis of cement packaging;
- Development, compaction and assembly of packing bales;
- Quantification of cement production;
- Logistic feasibility of transportation of cement trucks and bales.

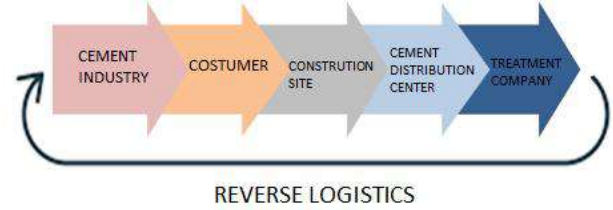


Fig. 1 - Reverse logistics flow for cement packaging

IV. MATERIALS AND METHODS

In order to represent the cement packages, 50 samples of the cement bags were collected in two random constructions and in the industrial unit (samples of cement bags before filling and consumption, called clean packs), respecting the four types of cement produced in the company. At the time of collection, priority was given to the intact packaging, those with only one opening (tear) for consumption, thus avoiding possible divergences in the evaluations. Thus, 5 samples of each type were selected for weighing the samples as shown in Figure 2.



Fig. 2 - A, B and C samples of post-consumer packaging and D unused packaging

For the physico-chemical analysis, the samples of each group were cut in sizes 5 cm x 5 cm and placed separately in the knife mill. The residues from this operation are collected in plastic bags for homogenisation and a reduced sample as shown in figure 3.



Fig. 3 - Knife mill and samples after grinding and a reduced sample.

4.1—Laboratory analysis of cement packaging

Laboratory analyses are important and should be performed to assess the suitability of these wastes for the co-processing phase in such a way that they do not impair the residue as an energy source and do not cause damage to the final quality of the cement.

4.1.1 Determination of the weight increase of post-consumer cement packaging

At this stage, the selected packages were weighed in a calibrated electronic balance and with reference to unused (clean) packages weight.

4.1.2 Determination of ash and higher calorific value (kcal/kg)

The calorific value and the ashes of the packages were determined by placing 1g of the crushed sample of the package in a pre-weighed nickel crucible. Thereafter, said crucible was placed in a calorimetric pump to be burned with pure oxygen. The ash inside the crucible was calculated by the mass difference. The calorific value, that is, the potential capacity of a material to release a given amount of heat, was determined in the calorimeter based on ASTM D240-17 [20] and the results are presented as kcal/kg.

4.1.3 Determination of chloride content in post-consumer cement packaging

The determination of the soluble chloride in the packages was carried out with titration of silver nitrate (AgNO₃).

4.2 Development, compaction and assembly of bales

Considering the heterogeneous conformation of the packages after the use and the economic feasibility for the reverse logistics, a bundle of compressed packages was developed for the transportation by trucks as shown in Figure 4. In this bundle, enveloped with cardboard and with mooring strips of carbon steel, with dimensions of 1.1 m x 0.50 m x 0.80 m, 1,113 packages with a total weight of 182.45 kg were used.

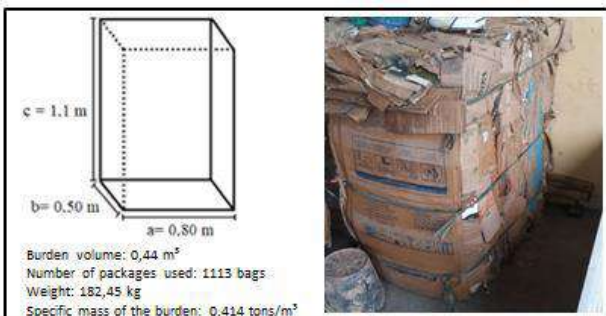


Fig. 4 - Loading of pressed packages for trucking

V. RESULTS AND DISCUSSION

The annual production of the industrial unit under study is 720 thousand tons of cement. The expedition of the cement in a radius of 200 km is realized of two forms: cement in bulk using bulk cement trucks and in sacks of cement of 50 kg. 308 thousand tons are transported in bulk and 420 thousand tons representing 840 thousand sacks of cement of 50 kg. In bulk they are arranged in cement storage silos, and the bags with cement go directly to a distribution centre or directly to civil works.

In the analysed samples of packages (Figure 2), a 17.46% increase in weight was observed in relation to the clean packages, which corresponded to cement and moisture residues. Table 1 below shows the average of the results of the packages referring to calorific value, ash content, humidity and chloride content.

Table 1 - Results of packages analysis

Types of packages	Calorific value kcal/kg	Chloride %	Ashes %	Moisture %
Clean	3614.3	0.10	4.94	3.39
Type I	3516.8	0.09	8.96	6.39
Type II	3638.5	0.07	5.33	10.23
Type III	3622.6	0.04	5.54	5.88
Mixtures	3625.8	0.09	11.67	8.71

All the samples analysed showed calorific values in the order of 3600 kcal/kg and were included in the results of several studies carried out with industrial waste in cement plants where the calorific value ranged from 2800 kcal/kg to 4500 kcal/kg [21-23].

In the analyses, much lower chlorine (chloride) levels were observed when compared to the maximum allowable reference of the unit under study, that is, greater than 0.4%. Some cement plants that burn waste from various sources where the chlorine content is higher than the values of the packages [24].

Unlike the process of transportation and storage of pre-consumer packages, when all care is taken to avoid contact with wet surfaces, the situations found at the sampling points in the post-consumer packages were not as careful. Therefore, post-consumer cement packages are more subject to moisture retention. In the analysis performed, it was possible to observe an increase of 3% to 7% in moisture when compared to the pre- and post-consumption packages.

The amount of ash in the samples is closely linked to the amount of cement removal adhered to the sampled particles, since the cement is the major component. The ashes of the packaging represented 4.94%, and after

consumption, there was an increase from 0.4% to 7.5% in the ash content. The low ash content also indicates the ease of burning most post-consumer packages, thus enhancing their ability to generate thermal energy.

The transport of cement bags from the cement plant to the storage and distribution centre is carried out on trucks with a maximum capacity of 36 tons. After delivery in the units, the trucks return to their origin, completely empty. In this scenario, the opportunity of using the return freight was observed between the recycling centres and the cement factory transporting the bales of the pressed packages (Figure 4). The truck has two trailers where it is possible to transport 90 bales with a total weight of 16.4 tons as shown in Figure 5.

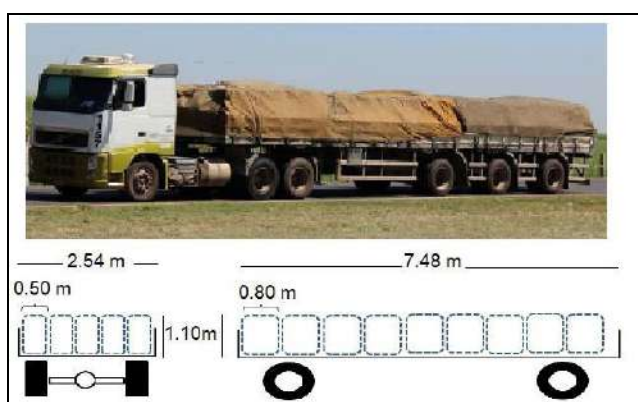


Fig. 5 - Truck with two trailers for loading cement bags or packing bales

VI. CONCLUSIONS

Based on the study carried out with post-consumer cement containers from a cement factory located about 200 km from the distribution and consumption zone, it is concluded that:

- Laboratory tests have shown that the packages have a calorific value of 3600 kcal/kg and ash content acceptable to be used as an alternative fuel for co-processing in a cement plant.
- The test bundle assembly proved feasible in order to ensure the compacting of a larger volume of the waste to be transported by the trucks using the return freight - that is, when the trucks return empty to the factory.
- Sustainable management of post-consumer cement packaging can be made via two sustainable destinations: recycling and coprocessing.
- It is possible to meet the reverse logistics of the National Policy on Solid Waste in Brazil when it accepts some of the requirements, such as an instrument of economic and social development characterised by a set of actions, procedures and means to enable the collection and restitution of solid

waste to the business sector, for reuse in its manufacturing cycle, called co-processing.

REFERENCES

- [1] Gohlke, O. (2009). Efficiency of energy recovery from municipal solid waste and the resultant effect on the greenhouse gas balance. *Waste Management & Research*, 27.9: 894-906. <https://doi.org/10.1177/0734242X09349857>.
- [2] Mills, R (2007). Sustainability, regulation and reverse logistics. *Henley Manager Update*, 18.4: 21-28. <https://doi.org/10.1177/174578660701800403>.
- [3] Arrieta, M. D. P.; Arrieta, F. R. P. (2018). KCS34 evaluation for WHR in cement industry. *International Journal of Advanced Engineering Research and Science*, 5, 11. <https://doi.org/10.22161/ijaers.5.11.27>.
- [4] Marelo, M.; Helwege, A. (2018). Solid Waste Management and Social Inclusion of Wastepickers: Opportunities and Challenges. *Latin American Perspectives*, 2018, 45.1: 108-129. <https://doi.org/10.1177/0094582X17726083>.
- [5] Brazil. Decree no. 7,404, dated December 23, (2010). Official Gazette of the Federative Republic of Brazil, Brasília.
- [6] John, V.M.; Agopyan, V. (2000). Recycling of construction waste. In: Seminar Recycling of Domestic Solid Waste, 2000, São Paulo, Brazil.
- [7] Rogers, D. S.; Tibben-Lembke, R. (1999). Going backwards: reverse logistics trends and practices. Pittsburgh: P. A. RLEC Press.
- [8] Stafford, F. N., Viquez, M. D., Labrincha, J., & Hotza, D. (2015). Advances and challenges for the co-processing in Latin American cement industry. *Procedia Materials Science*, 9, 571-577; <https://doi.org/10.1016/j.mspro.2015.05.032>.
- [9] Monteiro, L. P. C.; Mainier, F. B. (2008). Burning of unusable tires in clinker kilns. *Engevista*, 10.
- [10] Cembureau, C. S. I. (2009). Sustainable cement production: Co-Processing of alternative fuels and raw materials in the European Cement Industry. *Europe*, 2, 1-6.
- [11] Benestad, C. (1989). Incineration of hazardous waste in cement kilns. *Waste management & research*, 7.4: 351-361; [https://doi.org/10.1016/0734-242X\(89\)90072-4](https://doi.org/10.1016/0734-242X(89)90072-4).
- [12] Lockwood, F. C.; Ou, J. J. (1993). Burning refuse-derived fuel in a rotary cement kiln. *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy*, 1993, 207.1:65-70; https://doi.org/10.1243/PIME_PROC_1993_207_008_02.
- [13] Lamas, W. Q.; Palau, J. C. F.; Camargo, J. R. (2013). Waste materials co-processing in cement industry: Ecological efficiency of waste reuse. *Renewable and Sustainable Energy Reviews*, 19, 200-207. <https://doi.org/10.1016/j.rser.2012.11.015>.
- [14] Galvez-Martos, J. L.; Schoenberger, H. (2014). An analysis of the use of life cycle assessment for waste co-

- incineration in cement kilns. *Resour. Conserv. Recycl.*, 86, p. 118-131.
<https://doi.org/10.1016/j.resconrec.2014.02.009>.
- [15] Brasil, Resolução CONAMA nº 264 (1999). Licenciamento de fornos rotativos de produção de clínquer, para atividades de co-processamento de resíduos (Licensing of rotary kilns, clinker production for co-processing of waste activities), <https://www.areaseg.com/conama/1999/264-1999.pdf>. In Portuguese).
- [16] ABCP - Associação Brasileira de Cimento Portland (Brazilian Association of Portland Cement) (2018), Panorama do Coprocessamento (Scenario of Co-processing), <https://www.abcp.org.br>.
- [17] SNIC - Sindicato Nacional da Indústria do Cimento (National Union of Cement Industry), (2019). Cement producer park, <http://snic.org.br/>.
- [18] Pires, J. M. A.; Silva, J. L. G. (2006). Reverse logistics: a strategic tool for sustainable development. *Brazilian Journal of Regional Management and Development*, Taubaté, SP, v. 12, n 5, p. 143-181, dez.
- [19] Govindan, K.; Soleimani, H.; Kannan, D. (2015). Reverse logistics and closed-loop supply chain: A comprehensive review to explore the future. *European Journal of Operational Research*, v. 240, 3, 603–626. <https://doi.org/10.1016/j.ejor.2014.07.012>
- [20] ASTM D240-17 (2017), Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter, ASTM International, West Conshohocken, USA.
- [21] Erol, M; Haykiri-Acma, H.; Küçükbayrak, S. (2010). Calorific value estimation of biomass from their proximate analyses data. *Renewable energy*, 35.1: 170-173. <https://doi.org/10.1016/j.renene.2009.05.008>.
- [22] Mokrzycki, E.; Uliasz-Bocheńczyk, A. (2003). Alternative fuels for the cement industry. *Applied Energy*, 74.1-2: 95-100. <https://doi.org/10.1016/j.renene.2009.05.008>.
- [23] Kara, M. (2012) Environmental and economic advantages associated with the use of RDF in cement kilns. *Resources, Conservation and Recycling*, 68: 21-28; <https://doi.org/10.1016/j.resconrec.2012.06.011>.
- [24] Karstensen, K. H., Kinh, N. K., Viet, P. H., Tuan, N. D., Toi, D. T., Hung, N. H., & Thang, D. H. (2006). Environmentally sound destruction of obsolete pesticides in developing countries using cement kilns. *Environmental Science & Policy*, 9 (6), 577-586; <https://doi.org/10.1016/j.envsci.2006.05.005>.

A Proposed Model for Bioelectricity Cogeneration Activities Management in the Sugar-Energy Industry

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Abstract—The aim of this article is to propose a model based on Balanced Scorecard (BSC) to run the strategy of the sugar-energy companies regarding to the business unit for bioelectricity cogeneration. The model adds three new perspectives to the BSC namely environmental perspective, human resources perspective and supplier perspective. Bioelectricity cogeneration will become indispensable for the modernization of the sugarcane mills that already accounts for 2% of the Brazilian GDP in the economic sector of the sugar-energy industry. The low cost of bioelectricity cogeneration due to the use of residual sugarcane biomass as raw material such as bagasse, straws and tips, which are wastes of the production of sugar and ethanol process is a strong incentive for the sugar-energy industry. The opportunity to supply bioelectricity to the Brazilian Interconnected Electricity System arose when an unusual dry period occurred in the Southwest/Midwest regions. The achieved results on a model running show that it can be a useful management tool. The scientific value of this study is to present a model that demonstrates the possibility of adaptation of the BSC with emphasis on meeting specific industry demand. In addition, an environmental problem solved using bagasse, straws, tips from sugarcane to produce electricity.

Keywords—Balanced Scorecard, bioelectricity cogeneration, sugar-energy industry.

I. INTRODUCTION

The Sugarcane plays a strategic role in the Brazilian economy. Research and Development investment supported by the Brazilian Government caused a relevant upgrade in the traditional sugarcane industry. In addition to the production of sugar and ethanol, a new business opportunity arose with the burning of bagasse to generate the electricity surplus in the mills in an operation defined as bioelectricity cogeneration (Vasconcelos and Carpio, 2017).

The surplus electricity (supply) from the sugar-ethanol industry became available to the National Interconnected System (SIN). The electricity crisis (demand) caused by low rainfall in the Brazilian Southeast-Midwest regions, where the major hydroelectric power plants with water reservoirs are located complemented this new business opportunity (Vasconcelos and Carpio, 2017; 2015).

Even the industry's name changed from sugar-ethanol industry to sugar-energy industry. As a new business, it is necessary to provide efficient tools, techniques and management practices to plan, monitor and finally assess

positive financial and operational results for the new business unit administration in each mill.

The chain of the Brazilian sugar-energy industry sells US\$ 43.6 billions in end-products representing about 2% of the Brazilian GDP (Vasconcelos and Carpio, 2017; Novacana, 2015). This value is equivalent to the economic output of countries like Paraguay, North Korea, Afghanistan, Jamaica and Estonia. The mills and the agents involved in the economic activity around the production of cane, sugar, ethanol and bioelectricity generate a gross revenue higher than US\$ 100 billions per crop (Vasconcelos and Carpio, 2017; Novacana, 2015). These figures confirm the relevance of the sugar-energy industry for the Brazilian economy (Moraes et al., 2016).

According to IRENA (2016), the worldwide installed capacity to supply solid biomass for electricity generation reached 87,227 MW in the year 2015. Brazil is the country with the largest installed capacity, with 15.3% of the global total, followed by the USA (13.2%), China (11.8%), India (6.2%) and Japan (4.7%). The biomass source represents 9.03% of the electricity granted by the National Electric Energy Agency (ANEEL), which places

it as the third most important source of electricity generation in Brazil.

The Chamber of Electric Energy Commercialization (CCEE) reported that in the month of July 2016, cogeneration from sugarcane biomass achieved its historical record, with up to 8.1% of the Brazilian electricity consumption generated by the sugar-energy industry (UNICA, 2016).

The sugarcane harvest occurs from April to November in the Southeast/Midwest regions of Brazil. This is the period when drought occurs, impairing the water replacement in the reservoirs of the hydroelectric power plants in this region. Note that the main hydroelectric power plants with reservoirs are located in these regions. About 70% of the hydroelectric power plants reservoirs capacities are concentrated in the Southeast/Midwest regions (Vasconcelos and Carpio, 2015).

Due to the shortage of rain that occurred in Brazil Southeast/Midwest regions during 2001/2002, the hydroelectric power plant reservoirs had the water level reduced to critical levels, which led to electricity rationing (Vasconcelos and Carpio, 2015). Government actions since then increased the share of thermal electricity generation in the Brazilian electricity mix.

Another period with low rainfall happened during 2014 in the regions where hydroelectric power plants with reservoirs are located (Vasconcelos and Carpio, 2015). In this new period of rainfall shortage (2014/2015), Brazil's major hydroelectric water reservoirs reached critical levels. Thus, the National System Operator (ONS) authorized the thermoelectric generation plants to maintain the supply, meeting the demand for electricity throughout the period in an uninterrupted way (Vasconcelos and Carpio, 2015).

Since 2004 the sugarcane biomass has been increasing its participation as an input for the generation of bioelectricity. According to the Brazilian Energy Research Company (EPE, 2015), the national policies promoted the diversification of electricity generation. The Brazilian Electricity Regulatory Agency (ANEEL) announced that there were 7.9 GW of installed capacity for the cogeneration of electricity by the sugar-energy industry, at the beginning of 2014. During the month of May 2015, this capacity expanded to 9 GW.

EPE (2015) reported that 177 mills with sugar-energy production units provided surplus of electricity to the SIN. Since the total sugar-ethanol mills reaches 355 production units (UNICA, 2016), there is still growth potential in the supply of bioelectricity (Vasconcelos and Carpio, 2017).

According to the ONS, each 1,000 average MWh of bioelectricity delivered to the SIN during the dry season means savings of 4% of water from the reservoirs of the Southeast/Midwest subsystem (Vasconcelos and Carpio, 2017; Castro et al., 2010).

In the Regulated Contracting Environment (ACR) market, new energy sellers that had participated in the bioelectricity generation auctions for the years 2014, 2015 and 2016 have also evolved positively, reaching the level of US\$ 61.4/MWh in the LFA2015 auction (LFA: Alternative source energy auction only for wind electricity and bioelectricity). In April 2014, the cap-price of electricity on the Deregulated Contracting Environment (ACL) reached US\$ 234.86/MWh (Vasconcelos and Carpio, 2017; CCEE, 2015).

In order to meet the need for strategic management of the sugar-energy industry new business unit, this article proposes a model to carry on a strategical execution of bioelectricity cogeneration unit with the use of concepts and practices based on Balanced Scorecard.

II. BALANCED SCORECARD

Charan and Colvin (1999) pointed out that in 70% of the failed business strategies the problem is not in their formulation, but in their execution. Martin (2016) commented some survey findings underscoring the well-established fact that few leaders (only 8%) are good at both developing effective business strategies and executing them. A successful execution of the company strategy occurs when three key business processes to achieve strategic results are in place linking business strategy with the real world. They are the people objectives, the business strategy and the operational plan (Bossidy and Charan, 2002). According to these authors, the company's management seeks to get things done on time and with the expected quality.

The budget process in a company explains the planned results. These results are revenue, cash flow and profits, and the corresponding resources. However, the budget process does not address how or if it is possible to obtain the expected results. This requires adopting a consistent operational process, based on a business plan that links strategy with short-term and long-term goals. In order to reach its planned results, a company addresses individual goals and defines employee responsibilities (Bossidy and Charan, 2002).

Kaplan and Norton (1992) presented the findings of their studies along with companies, detailing the feasibility of the processes and the description of the benefits achieved with the application of a balanced system of strategic

measurement, that is known as Balanced Scorecard (BSC).

Few years later, Kaplan and Norton (1996) summarized the results achieved with the implementation of the BSC in companies as the main organizational tool for management processes. Some of these processes, such as setting individual and team goals, reward plans, allocation resources, planning and budgeting, feedbacking, recording and publishing of the strategic learning, should be considered.

According to Kaplan and Norton (1996), the BSC complements financial measures of the past performance with measures of vectors that drive the future performance. For this, BSC uses four perspectives namely Financial Perspective, Customer Perspective, Internal Processes Perspective, and Learning and Growth Perspective.

Innovative companies adopt the philosophy of the scorecard to manage the implementation of the strategy and enable critical management processes. These processes are (i) to clarify and to translate the vision and the strategy, (ii) to communicate and to link strategy objectives with measures, (iii) to plan, to set goals and to align strategy initiatives, and (v) to improve feedback and strategic learning. Finally, a tool to carry out the strategy must be put forth.

In the literature, the use of the BSC proposed to meet several needs. Among these, Epstein and Manzoni (1998) used the BSC to capture the complexity of the performance in the organization. Hauser and Katz (1998) used the BSC to choose the metrics that are critical to the success for actions taking and decisions. Kaplan and Norton (1992) used the BSC to establish measures to reflect and materialize the mission and the strategy of the company.

To achieve the purpose of the company as a whole, Kaplan (1999) suggested assigning the company scorecards gradually, distributing the implementation effort and also adjusting and refining the goals and needs in all sectors of the company.

Prieto et al. (2006) studied the main difficulties encountered overall, to create and compose a guide for the development of their research. They considered the comment of Kaplan (1999) about the complexity in developing and implementing a BSC management system in a company. For this, Prieto et al. (2006) proposed a discussion of “critical success factors” in implementing the BSC, change management processes and some techniques involved behind the scenes of the implementation. In some cases reviewed during their research, Prieto et al. (2006) concluded that the BSC

conduction by middle management is often focusing on short-term results and metrics. Cao et al. (2015) developed some key performance ratios (KPI) based on “key success factors” for each original four BSC dimensions.

The human dimension in the BSC model is not ignored. Kaplan and Norton (1992) indicated that the human dimension is part of the learning and development activities. The human dimension has its basis on the employee development, supported by improving the implementation of internal processes.

Notwithstanding, Thompson and Mathys (2013) concluded that, like many organizations that use the BSC, it is imperative that the employee's perspective should be added to their scorecard. It is important to pay attention on a valuable additional element to the sustainability of the organization.

The research developed by Thompson and Mathys (2013) showed a strong link between employee engagement, customer engagement and improving organizational performance. They emphasized the focus on the employee engagement as a key factor to meet the customer's needs and to achieve the financial goals, with a direct impact on business profitability. Hence, the employee's perspective should be included in the BSC. An effective functioning of the organization requires proper management of the performance perspective of internal processes as well as workforce perspective. The learning and growth perspective then, becomes a source to develop employees in the execution of the key processes required to meet financial targets and customer's expectations.

Through the alignment of the main perspectives defined by the senior leadership team, the company management can perform the measurement of the activities and implement the conceptual tools to build a culture focused on the employee with direct impact on the planned outcomes (Thompson and Mathys, 2013).

Zeng and Luo (2013) studied the BSC utilization in companies located in China. They presented barriers and obstacles regarding the implementation of the BSC in that country. They appointed two main obstacles such as the cultural barrier and adherence of the standards used by the BSC.

Two studies developed in Portugal (Guimarães et al., 2010; Mendes et al., 2012) considered the application of BSC in the services of collection and treatment of solid waste.

Guimarães et al. (2010) discussed the potential application of BSC in managing the public service of waste collection into four types of provision of that public service, considering the optical of the service operator.

Guimaraes et al. (2010) analyzed management and direct operation by the city authority, as well as the use of public-private partnership. They focused on Portugal municipalities, semi-autonomous utilities, municipal companies and mixed companies. Among the findings of the case studies, these authors presented strengths in the use of the BSC as a strategic tool, such as increasing knowledge of the activities and identifying specific aspects that require a greater management attention.

Mendes et al. (2012) focused on the Urban Hygiene and Solid Waste Division of the Loulé Municipality in Portugal. They concluded that treatment of waste assists in implementing modern techniques and practices for waste management. They found evidences about focusing on the strategic management of the relationship with the client and server, and in ensuring positive combination for the improvement of services.

Norrie and Walker (2004) discussed ways to measure the progress of activities in project management during the project life cycle. They proposed the use of tools based on BSC to track the operational progress of the project team activities. They concluded that the project management becomes more effective in controlling and monitoring activities, in order to extend the results obtained by the project team after the adoption of tools based on BSC.

The main feature of the BSC in the strategy implementation management lies in the measurement of objectives and financial and non-financial ratios derived from both business vision and strategy. By using the BSC, the resistance to the controls and to the most significant goals is overcome by the participants due to the clarification of the causal relationships between the strategic initiatives (Kaplan and Norton, 1997).

The participatory process of implementing the BSC should involve all levels of the organization, not only the executive levels. Moreover, the BSC encourages communication between different areas of the company to complement the causal relationships within the multidisciplinary strategic objectives. The BSC translates mission and strategy into objectives and measures, organized according to four different perspectives such as financial perspective, customer perspective, internal processes perspective and learning and growth perspective. The scorecard creates a structure, a language to communicate to the organization the mission and strategy previously defined. The BSC uses ratios to inform employees about the vectors of the current and future success of their duties (Kaplan and Norton, 1997).

To use BSC companies have two main tasks. Firstly, it is necessary to prepare a scorecard, and then make good use of it. These two tasks are dependent. With the onset of the

use of scorecards for key processes management, executives have a better understanding of the scorecard itself, realizing that if some steps do not work, which ones should receive specific changes and what are the new strategic process measures that arise and should be part of the scorecard. Kaplan and Norton (1997, 2004) explained that the construction of a BSC linking mission and strategy of a company to goals and explicit measures is just the beginning of the use of the scorecard as a management system. Through the communication, it is sought the alignment of all employees with the company's strategy, facilitating the establishment of goals and their subsequent fulfillment.

Kaplan and Norton (2004) proposed the Strategic Map to describe the logic for the connection of the strategy with the goals of the critical internal processes that create value to the business. For each defined process is stated the responsibility of each employee involved. The BSC translates the objectives of the Strategic Map into ratios and targets. To accomplish the objectives and goals, it is necessary to set and implement activities delegated to employees.

Therefore, according to Kaplan and Norton (2004), managers need to identify the strategic initiatives necessary to achieve the proposed goals. These initiatives provide results, since there are the strategy execution and monitoring of the progress of these initiatives. Action plans for strategic initiatives should have the correct alignment, as well as they should define and provide the necessary resources. They must have an integrated organization. With the expected results once financially described the Strategic Map, objectives are achieved and measured. Ratios according to the financial perspective of the BSC are used (Kaplan and Norton, 2004).

Most of the BSC published articles presented strategic development and implementation in a large variety of industries. There is additional published literature on BSC utilization by industries including the following contributions: Duarte and Machado (2015), Cheng and Liang (2014), Correa et al. (2014), Liu et al. (2014), Tjader et al. (2014), Xiaomei et al. (2013), Kunru (2012), Wu et al. (2011).

The practice shows that the strategy is not an isolated management process, but one of the logical steps in which are involved all collaborators (executives and employees) within the organization.

III. MATERIAL AND METHODS

The methodology proposed in this study focuses on the strategic execution of electricity cogeneration by sugar-energy industry. In addition to the BSC four original

perspectives, as defined by Kaplan and Norton (1996), the proposed methodology adds three new perspectives to consolidate the implementation of the sugar-energy industry strategy. Environmental perspective, human

resources perspective and supplier perspective defined to complement the proposed methodology as shown in Fig. 1.



Fig.1 – Proposed methodology with company’s mission, strategy and execution connections

The environmental perspective considers for environment protection the pollution control, such as the quality of soil, air and water (Vasconcelos et al. 2017), the existence of filters to trap the soot from chimneys of boilers, the reuse of vinasse (Moraes et al., 2015; Christofoletti et al., 2013) to generate gas rich in methane through anaerobic digestion. The vinasse, after passing through the biodigestion process, together with the boiler ash and the soot from filters, can form a mixture for fertilization and irrigation of sugarcane fields. This perspective also considered the preservation of quality of the water used in the plant with proper treatment, its reuse and later discharge to the environment. Protection and restoration of the native riparian vegetation, the satisfaction and the commitment of local stakeholders are considered.

In the human resources perspective the focus is on the collaborators individual participation (employees and outsourced workers commitment and engagement) with the procedures and internal controls, the scheduled deliveries, ultimately with the company’s success. This initiative leads to developing strategies and programs to support the employee activities and to building an engagement culture that expands the number of employees engaged in the workforce.

In the supplier perspective, emphasis is given to the relationship with the owners of fields leased for sugarcane crop. Historically in Brazil, the inappropriate

treatment given by the administration of the sugar-energy mills to farmers leads to further reduction of production due to crop exchange in subsequent seasons. Not getting the expected value for the lease of the lands, farmers leave the cultivation of sugarcane and immediately begin to grow other crops that can offer higher return, for example: grains such as soy bean and corn.

For each of the seven perspectives – namely the four original BSC perspectives and the three additional proposed perspectives – considered in the proposed methodology, the correlated processes with their respective objectives, ratios and targets are defined. These objectives comply with the logic applied in business management. Each objective was set to meet the expectations of the management team and of concern shareholders related to the strategy of a profitable company. This definition is the basis to allow the management team to measure the general productivity achieved. It is taken in account the strategic plan, company’s mission, resulting actions from supplier perspective application in business and in relation to the environment protection. Table 1 shows the preview of the initial architecture with the chosen set of objectives and ratios for each one of the seven perspectives. Some correlated ratios are suggested.

Table 1 – Proposed BSC

Perspective	Balanced Scorecard		Action Plan		Achieved Results	
	Objectives	Indicators	Target	Budget	Actual	Target x Actual
Financial	Increase the return to shareholders Maximize asset utilization	ROI - Returns on investment				
		CROCI -Cash return on capital invested				
Customers	Service contracts	ROE - Return on own capital				
		Marketshare				
Suppliers	Keep long-term suppliers	Contract net profitability				
		Customer satisfaction				
Environmental	Protect and preserve the environment	Raw material cost				
		Land rental cost				
Internal Process	Optimize the use of assets	Effluent control and treatment				
		Native vegetation conservation				
Learning and Growth	Developing skills	air pollution control				
		soil protection				
Human Resources	Keep climate conducive to action through alignment and training	Equipment life cycle policy				
		Total quality procedures				
Human Resources	Keep climate conducive to action through alignment and training	Employee profitability				
		Employees turnover				

To meet the four original perspectives of BSC objectives typically used in companies of any industry were selected. Increase the return to shareholders and maximizing assets utilization are natural targets for the financial perspective. Generic ratios generally accepted in many industries are used to measure each objective.

3.1 Financial Perspective ratios

To increase the return to shareholders, selected ratios were return on investment – ROI and the cash return on capital invested – CROCI.

$$ROI = \alpha / \beta \tag{1}$$

where:
 α is net profit after interest and taxes
 β is total of assets

Equation 1 is used to calculate the return on investment of the electricity cogeneration unit. It is a performance measure (ratio or indicator) used to evaluate the efficiency of the investment done.

$$CROCI = EBITDA / \gamma \tag{2}$$

where:
 $EBITDA$ is Earnings Before Interest, Taxes, Depreciation, Amortization, Rent and Management fees
 γ is Capital Invested

Equation 2 is used by management team to calculate the cash return on capital invested on electricity cogeneration business unit, calculated on a cash basis.

To maximize the use of assets, the selected ratios were: profitability (profit margin) and return on own capital - ROE.

$$Profit\ Margin = \delta / \lambda \tag{3}$$

where:
 δ is net profit
 λ is total sales

Using Equation 3 the management team measures the amount of net income earned with the electricity sales. This ratio measures how effectively the business unit can transform sales into net income, which means the efficiency of the electricity generation unit.

$$ROE = \delta / \eta \tag{4}$$

where:
 δ is net profit
 η is net worth

Equation 4 indicates the profitability of the electricity cogeneration business unit. It measures the shareholders earning based on investment done in the business unit. The higher the ratio is, the more efficient the management is.

A similar logic was adopted for the definition of objectives and related ratios for the other three original perspectives of BSC, the customer perspective, the perspective of the internal processes and the learning and growth perspective.

3.2 Customer perspective ratios:

$$Marketshare = \lambda / \rho \tag{5}$$

Where:
 λ is total sales
 ρ is total bioelectricity market

Equation 5 is used to calculate the participation of the electricity cogeneration business unit in the relative market. Using marketshare ratio, the management team have a view of the position occupied by their business unit in comparison with other companies in the cogeneration market.

$$Contract\ Net\ Profitability = \lambda - \partial \tag{6}$$

where:
 λ is total sales

∂ is total production cost

Equation 6 is used to have a better view of individual contract signed to sell electricity in both ACR and ACL markets.

3.3 Customer satisfaction – $Csat$

$$Csat = v/o \quad (7)$$

where:

v is number of customers whose reported experience exceeds satisfaction goals

o is total number of customers

Equation 7 is used to calculate the customer satisfaction ratio based on reported satisfaction informed by each customer. Due to electricity is a commodity this ratio has a high difficulty degree to be calculated. In general, the mill management team can carry on a customer satisfaction survey on yearly basis to inform shareholders as part of the annual balance

3.4 Internal Processes Perspective ratios

Equipment life cycle policy

Total quality procedures

No ratios are suggested for internal processes perspective due to the necessity to define and use, in each company, specific ratios related to Total Quality Management (TQM) and life cycle policies and programs.

3.5 Learning and growth Perspective ratios

$$Employee\ profitability = \delta/\mu \quad (8)$$

where:

δ is net profit

μ is number of employees

Equation 8 is used by the management team to control the individual contribution of each employee to the profitability of the electricity cogeneration business unit.

$$Employee\ turnover = \theta/\mu \quad (9)$$

where:

θ is number of fired employees

μ is number of employees

Equation 9 is used to verify the turnover during the period. Depending on the ratio calculation results, a specific management action should be taken on human resource area.

For the three perspectives proposed by the model such as the supplier perspective, the environmental perspective and the human resources perspective, objectives and specific ratios were defined. These ratios were adapted to be used in a electricity business unit cogeneration of a sugar-energy industry company.

3.6 Suppliers Perspective ratios

For the supplier perspective, it was considered the importance of this perspective for the industry and for the business unit of electricity cogeneration. The point

selected for the supplier perspective was to keep suppliers long-term assets. The importance of the supplier perspective for the sugar-energy industry is evidenced by the need to keep the productive fields for long period, since, depending on the type of sugarcane grown a sugarcane crop can remain productive for up to fifteen years.

The ratios defined for the supplier perspective are raw material cost participation and land rental cost participation.

$$Raw\ material\ cost\ participation = \tau/\partial \quad (10)$$

where:

τ is raw material acquisition cost

∂ is total production cost

Equation 10 is used to manage the total cost of raw material acquisition. The purchase of sugarcane from farmers without contract previously signed is one of the application of this ratio. Another one is the extra purchase of bagasse from nearby mills to increase the electricity cogeneration out of harvest period.

$$Land\ rental\ cost\ participation = \varphi/\partial \quad (11)$$

where:

φ is land rental cost

∂ is total production cost

3.7 Environmental Perspective ratios

On the environmental perspective, the protecting and preservation of the environment were the main objective. As its primary input is the sugarcane, this objective is important for the sugar-energy industry. The sugarcane crop needs large fields, typically located in areas without artificial irrigation. Native vegetation and riparian areas are cleared to enlarge the productive area. The industrial process of production of sugar and ethanol generates waste pollutants, such as bagasse and vinasse in great proportions. Ratios are defined to the control and treatment of effluents, the conservation and protection of native vegetation, and soil protection.

$$Native\ vegetation\ conservation = \omega/\vartheta \quad (12)$$

where:

ω is native vegetation area

ϑ is total area

Equation 12 is used to control the actions on environment care, such as the ratio of native vegetation last as well as reforestation actions taken on mills property. Depending on calculated ratio, this information could be used by public affair department.

Air pollution control through chimneys filters performance to be controlled according to filter specifications.

Effluent control and treatment of disposed water.

Soil quality protection to maintain optimal chemical composition of soil.

3.8 Human Resources Perspective ratios

Human resources are the main productive factor of any industry. Therefore, the human resources perspective was included in the model. In the original BSC, there is already a weight set in the performance of the employees. Subsequent authors have presented benefits of employees to have professional treatment to achieve the strategic company objectives. In the proposed model, human resources received additional importance because in the sugar-energy industry there is difference in the treatment of individual employees.

Thus, the objective set for the human resources perspective to maintain favorable climate to ensure the alignment of employees with the company's goals and due to qualify and develop human resources. The proposed indicator is to keep a positive organizational action through the maintenance and encouraging the culture of employee engagement with the company policies.

$$Employee\ engagement = \kappa/\zeta \quad (13)$$

where:

κ is total employees objectives already achieved

ζ is total of employees objectives

Equation 13 is used to calculate the participation of each employee in the effort to achieve the strategic results of the electricity cogeneration business unit.

3.9 Targets definition

At this point, it is necessary to establish measurable targets for each objective indicator. The objectives for each perspective are defined with detailed ratios, considering their quantification and the way to present planned results.

Targets should be set in two ways. Considering increase percentages over the previous period, e.g. increasing by 3% the revenue that had been earned in the period before for the electricity cogeneration unit. Another option is to consider a new percentage reached by the new target, e.g. increasing 2% the share in the bioelectricity cogeneration market in the next fiscal year.

Up to now it has been defined, for each perspective, the objectives, the ratios used to measure the results and the upcoming period desired targets to be checked against the previous period, e.g. year, semester, quarter, or month.

3.10 Implementation

Once the plans are approved, development activities are managed (monitored, supervised and controlled). Hitherto, the proposed methodology have passed through the periods of planning and development (when the execution takes place), to achieve the strategic objectives

of the business unit and hence of the organization, in a given time period. To complete the proposed methodology, it is still necessary to present the achieved results (actuals) and to check against the planned results (target) from the approved plan.

After comparing planned objectives with the achieved results, management decision is necessary. These strategic decisions ensure that some adjustments may be necessary and enough to start a new cycle of planning, execution and control in order to carry out the future business strategy of the sugar-energy industry.

To implement the proposed methodology and use it in an efficient way, six steps proposed by this study should be executed in the sequence (Fig. 2):

Step 1: Define objectives for each one of the seven perspectives;

Step 2: Define ratios to be used to measure progress of each objective;

Step 3: Define and approve action plan (target and budget) values for each indicator defined in Step 2;

Step 4: Measure results already achieved for each indicator (target x actuals);

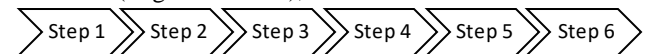


Fig.2 – Logical steps on the proposed methodology

Step 5: Make corrections when and where necessary;

Step 6: Approve achieved results.

IV. RESULTS AND DISCUSSION

There are many well established companies in the sugar-energy industry in Brazil. In recent decades, the operations of multinational groups consolidated with investment in the industry through acquisition as well as establishment of new businesses.

At the same time, national groups strengthened during the recent growth period of the Brazilian economy and followed the same path. Driven mainly by the government incentive program for ethanol to replace and to complement the use of gasoline in Otto-cycle motor engines, many national groups increased their investments in the sugar-energy industry.

Dependent on pricing policies for ethanol – historically linked to the price of gasoline –, which have always been handled by the federal government in order to contain inflation, the entrepreneurs of the sugar-energy industry make use of official loans and tax incentives. The construction of plants to produce only ethanol was encouraged by the government and the entrepreneurs were at the mercy of the controlled official prices.

Yet the plants that produce ethanol and sugar have had more room to choose the type of product to be manufactured, according to the demand behavior in Brazil and overseas. In this case, business owners seek the best return based on international price fluctuations of sugar and ethanol commodities, traded on the Chicago Board of Trade. Thereby, the production of sugar and the production of ethanol alternate.

For electricity, there is no export market and the domestic demand follows the programming and the centralized decision to electricity delivery made by the National Operator of the Electricity Network (ONS). The sale of electricity in the regulated market (ACR) occurs through auctions organized by local authorities. Electricity sale on the deregulated market (ACL) has the maximum price set by the government. Transactions on the ACL directly negotiated by vendor companies with the consumer companies.

In larger sugar-energy companies, the introduction of a new front to meet the demand for bioelectricity treated as a new business unit. The administrative and strategic company internal processes are practiced also in the new business units. Data collected from the daily operation are inputted into the modules of the integrated management systems. The accounting, financial and management data obtained is jointly processed by the integrated computer systems of each company.

During visits to four plants located in the region of Grande Dourados, Mato Grosso do Sul state, Midwest region of Brazil, it was observed that the electricity cogeneration does not receive adequate management attention. The visited mills neither use bagasse, tips and straw from sugarcane to produce second-generation ethanol nor use vinasse in the anaerobic biodigestion process to produce biogas.

Based on the obtained answers and through direct observation during those four visits, it was found that there is no specific tool for managing the electricity cogeneration. Furthermore, the transformation of the traditional sugar-alcohol industry into a new sugar-energy industry has a representative impact on company financial and operational results and is more than a simple inclusion of a new business unit in each mill.

In one of the visited mills, the proposed methodology was tested using actual data. Once analyzed, the management decision considered the obtained results positive and useful for the business.

3.1 Methodology application

Following the proposed methodology, the six logical steps (Figure 2) were executed. Objectives and ratios for each one of the seven perspectives (Figure 1) were

defined to consolidate a business unit of electricity cogeneration. The taken decision was to use the objectives and ratios as proposed in Figure 1.

The selected mill processed 2 million tons of sugarcane in the year-one harvest. According to the industry standard, 1 ton of sugarcane produces 250 kg of bagasse at 50% moisture and 205 kg of straw and tips (UNICA, 2015).

According to installed boilers capacity, 1 ton of bagasse fed into a boiler is enough to produce up to 14 MW. For the industrial process, there is up to 40% of the electricity produced for internal consumption (during the harvest period) and the rest (60%) supplied to bioelectricity cogeneration process. As the harvest period lasts 8 months a year, 4.7 GW of bioelectricity are available for cogeneration per year.

The sale of the bioelectricity produced occurred as follows: 70% to meet the ACR contracts, whose price was set in US\$80.00 per MWh. The remaining 30% to be negotiated in the ACL, at the average price of US\$82.86 per MWh.

For the following year, called year-two, the set goal was to expand the sale of electricity in the ACL by 10%. For the planned additional cogeneration, there is the burning of straw and tips collected from the sugarcane fields, soon after the harvest.

The collection of straw and tips is to be up to 60,000 tons. It is worth mentioning that there will be no negative impact on the next sugarcane crop harvest, as more than half of the straw and cut tips remain on the ground. Table 2 tabulates the details of the achieved results.

Table 2 – Electricity cogeneration business unit. Year-one and Year-two production

Description	Year-One	Year-Two
Production (sugarcane ton)	2,000,000.00	2,000,000.00
kg bagasse/sugarcane ton	250.00	250.00
kg straw and tips/sugarcane ton	204.00	204.00
ton of produced bagasse	500,000.00	500,000.00
ton of harvested straw and tips	0.00	60,000.00
GW generated	7.80	8.60
GW delivered (cogeneration)	4.70	4.84
Sold ACR	3.30	3.30
Sold ACL	1.40	1.54
ACL contracts average price - US\$	80.00	84.29
ACL contracts average price - US\$	82.86	91.43

With straw, tips and bagasse, there will be enough raw material to feed the boilers during the harvest period as well as one of the boilers that remain working in the off-season specifically for bioelectricity cogeneration. Cogeneration takes place during 12 months without interruption in the year-two. This means that besides the eight months of normal harvest, the cogeneration of bioelectricity will last four additional months in the year.

In this additional period, the total bioelectricity generated is sold since the ethanol and/or sugar production lines are not in operation activities.

The first paragraph under each heading or subheading should be flush left, and subsequent paragraphs should have a five-space indentation. A colon is inserted before an equation is presented, but there is no punctuation following the equation. All equations are numbered and referred to in the text solely by a number enclosed in a round bracket (i.e., (3) reads as "equation 3"). Ensure that any miscellaneous numbering system you use in your paper cannot be confused with a reference [4] or an equation (3) designation.

V. CONCLUSION

This article aimed to present a model to run the strategy of the bioelectricity cogeneration with the use of concepts and practices based on the Balanced Scorecard. The need for better planning and monitoring of results for each mill as a whole and especially for the business unit of electricity cogeneration is an issue. It uses the sugarcane bagasse as raw material, which is a by-product of the production process of sugar and ethanol. The straw and tips that were selected during the cutting and harvesting of sugarcane crop, which were scattered throughout the field to serve as protection and fertilizer, can be collected at the ratio of up to 50% and may be burned in boilers together with the bagasse, or even separately. Thus, a new business perspective opens up with the selling of electricity in the ACL market during 12 months a year. Consolidating the electricity cogeneration activity in companies of the sugar-energy industry, it is clear that there is a need to use techniques and management practices to monitor and assess results of the new business unit. As well, it proposed the use of a model for physical monitoring of financial and operational activities developed from an adaptation of the BSC.

The article demonstrated the achievement of the positive strategy with the properly measurement and management. The proposed management model with three additional perspectives provides for literature an improved alternative to use Balanced Scorecard.

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REFERENCES

- [1] Bossidy, L. and Charan, R. 2002. Execution. Crown Business, New York, 2002.
- [2] Cao, Y.; Zhan, K.; Yang, J.; Xiong, W. 2015. Constructing the integrated strategic performance indicator system for manufacturing companies. International Journal of Production Research, vol. 53, no. 13, pp. 4102-4116. Taylor & Francis Group. <<https://dx.doi.org/10.1080/00207543.2014.994715>>
- [3] Castro, N. J.; Brandão, R.; Dantas, G. A. 2010. A bioeletricidadesucroenergéticanamatrizeleétrica. In: Etanol e Bioeletricidade, a cana de açúcar no futuro da matrizenergética. Cap. 5, p. 136-153. Organizadores: Souza, I. I. e Macedo, I. C. ÚNICA, SP.
- [4] CCEE. Câmara de Comercialização de EnergiaElétrica. 2015. PLD: Histórico de PreçoSemanal.
- [5] Charan, R. and Colvin, G. 1999. Why CEO's Fail. Fortune, 21 of June, 1999.
- [6] Cheng, H. C. and Liang, Z. X. 2014. A strategic planning model for the railway system accident rescue problem. Transportation Research Part E. pp75-96. Elsevier. <<http://dx.doi.org/10.1016/j.tre.2014.06.005>>
- [7] Christofolletti, C. A.; Escher, J. P.; Correia, J. E.; Marinho, J. F. U.; Fontanelli, C. S. 2013. Sugar-cane vinasse: Environmental implications of its use. Waste Management 33, p. 2752-2761.
- [8] Correa, M. G.; Prochnik, V.; Ferreira, A. C. S.; Vianna, D. S. C. 2014. Brazilian hospital employee perception of the BSC. Latin American Business Review vol 15, pp. 141-166. Taylor & Francis Group. <<http://dx.doi.org/10.1080/10978526.2014.905162>>
- [9] Duarte, S.; Machado, V. C. 2015. Investigating lean and green supply chain linkages through a balanced scorecard framework. International Journal of Management Science and Engineering Management vol. 10, no. 1, pp. 20-29. Taylor & Francis Group. <<http://dx.doi.org/10.1080/17509653.2014.963111>>
- [10] EPE – Empresa de PesquisaEnergética. 2015. Plano Decenal de Expansão de Energia 2024. Available in: <<https://www.epe.gov.br/PDEE/PDE%202024.pdf>>. Accessed in 17 of September, 2015.
- [11] Epstein, M. and Manzoni, J. F. 1998. Implementing corporate strategy: from tableaux de board to balanced scorecards. European Management Journal, v.16, n. 2, p. 190-203.
- [12] Guimarães, B.; Simões, P.; Marques, R. C. 2010. Does performance evaluation help public managers? A balanced Scorecard approach in urban waste services. Journal of Environmental Management, v. 91, p. 2632-2638.
- [13] Hauser, J. and Katz, G. 1998. Metrics: you are what you measure! European Management Journal, v. 16, n. 5, p. 517-528.
- [14] IRENA – InternationalRenewable Energy Agency. 2015. Solid biomass and renewable waste – Renewable energy capacity statistics 2015. Available in: <<http://www.irena.org/Publications>>. Accessed in 14 of September, 2015.
- [15] Kaplan, R. S. and Norton, D. P. 1992. The balanced scorecard measures that drive performance. Harvard Business Review, v.70, n.1, p. 71-79.

- [16] Kaplan, R. S. and Norton, D. P. 1996. Using the balance scorecard as a strategic management system. *Harvard Business Review*, v. 74, n.1, p.75-85.
- [17] Kaplan, R. S. and Norton, D. P. 1997. *A estratégia da mação: Balanced Scorecard*. Editora Campus, Rio de Janeiro.
- [18] Kaplan, R. S.; Norton, D. P. 2004. *Strategic Maps*. Harvard Business School Publishing Corporation.
- [19] Kaplan, R. S. 1999. Can bad things happen to good scorecards? *Harvard Business School Press: Balanced Scorecard: Insight, experience and ideas for strategy-focused organization report*. Article B9911D.
- [20] Kumru, M. 2012. A balanced scorecard-based composite measuring approach to assessing the performance of a media outlet. *The Services Industries Journal* vol. 32, no. 5, pp. 821-843. Routledge, Taylor & Francis Group.
- [21] Liu, Q.; Shi, P.; Hu, Z.; Zhang, Y. 2014. A novel approach of mining strong jumping emerging patterns based on BSC-tree. *International Journal of System Science*, vol. 45, no. 3, pp. 598-615. Taylor & Francis Group. <<http://dx.doi.org/10.1080/00207721.2013.724110>>
- [22] Martin, R. L. 2016. Strategy and Execution are the Same Thing. *Harvard Business Review – Strategy*. HBR. January 19, 2016.
- [23] Mendes, P.; Santos, A. C.; Perna, F.; Teixeira, M. R. 2012. The balanced scorecard as an integrated model applied to the portuguese public service: a case study in the waste sector. *Journal of Cleaner Production*, 24, p. 20-29. Elsevier.
- [24] Moraes, A. F. D.; Bacchi, M. R. P.; Caldarelli, C.E. 2016. Accelerated growth of the sugar-cane, sugar, and ethanol sectors in Brazil (2000-2008): Effects on municipal gross domestic product per capita in the south-central region. *Biomass and Bioenergy* 91, p. 116-125. Elsevier. <<http://dx.doi.org/10.1016/j.biombioe.2016.05.004>>
- [25] Moraes, B. S.; Zaiat, M.; Bonomi, A. 2015. Anaerobic digestion of vinasse from sugar-cane ethanol production in Brazil: Challenges and perspectives. *Renewable and Sustainable Energy Reviews*, 44, p. 888-903. Elsevier. <<http://dx.doi.org/10.1016/j.rser.2015.01.023>>
- [26] Norrie, J. and Walker, D.H.T. 2004. A balanced scorecard approach to project management leadership. *Project Management Journal* 47, pp.47-54. ISSN 8756-9728/03. PMI
- [27] Novacana. 2015. Um negócio de US107 bilhões: panorama do PIB da cadeia sucroenergética. Available in: <<http://www.novacana.com/n/industria/usinas/negocio-us-100-bilhoes-panorama-pib-cadeia-sucroenergetica-031115/>>. Accessed in november, 2015.
- [28] Prieto, V. C.; Pereira, F. L. A.; Carvalho, M. M.; Laurindo, F. J. B. 2006. Fatores críticos na implementação do Balanced Scorecard. *Gestão & Produção*, v. 13, n.1, p. 81-92
- [29] Thompson, K.R. and Mathys, N. J. 2013. It's time to add the employee dimension to the balanced scorecard. *SciVerse Science Direct – Organizational Dynamics*, v. 42, p. 135-144.
- [30] Tjader, Y.; May, J. H.; Shang, J.; Vargas, L. G.; Gao, N. 2014. Firm-lever outsourcing decision making: A balanced scorecard-based analytic network process model. *Int. J. Production Economics* 147, pp. 614-623. Elsevier. <<http://dx.doi.org/10.1016/j.ijpe.2013.04.017>>
- [31] UNICA – União da Indústria de Cana de Açúcar. 2016. A bioeletricidade da cana em números – maio de 2016. Available in: <<http://www.unica.com.br/bioeletricidade>> Accessed in 14 of May 2016.
- [32] Vasconcelos, P. S. and Carpio, L. G. T. 2015. Estimating the economic costs of electricity deficit using input–output analysis: the case of Brazil. Printed Version published in *Volume 47, 9, p. 916-927, 2015. Applied Economics*. Online version, Dec 2014. dx.doi.org/10.1080/00036846.2014.982858
- [33] Vasconcelos, P.E.A.; Silva, L. F.; Vasconcelos, P. S.; Schindwein, M. M. 2017. An Analysis of the environmental responsibility and Sustainability of Bioenergy Mills. *Book of Proceedings of the 3rd International conference on Energy and Environment: bringing together Economics and Engineering*. Volume 1, p. 263-268. School of Economics and Management of the University of Porto, Portugal. ISSN 2183-3982. ISBN 978-972-95396-9-5.
- [34] Vasconcelos, P. S. and Carpio, L. G. T. 2017. Bagasse, Straws, Tips and Vinasse: from Sugarcane Waste to a Clean and Renewable Bioenergy Source. *International Journal Advances in Social Science and Humanities – IJASSH*. March 2017, vol. 5 – Issue 3, p. 27-37.
- [35] Wu, W. H.; Lin, C. T.; Peng, K. H. 2011. Compare strategy of different hospitals on the global budget system. *Journal of Information & Optimization Sciences* vol. 32, no. 1. Pp. 169-187. Taru Publications.
- [36] Xiaomei, F.; Jie, L.; Ziliang, T.; Xingchen, M.; Yi, Z.; Ting, Y. 2013. Discussion of the application based on BSC ratios in performance evaluation of clinical departments of public hospitals. *Chin Med Rec. Engl. Ed.* Vol 1 no. 3, pp. 92.

Cost Reduction with Environmentally Correct Destination of Liquid Waste in Machining Processes

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Abstract—Machining processes use synthetic oils, either cutting or soluble, for the heavy processing stage, generating a liquid residue, composed largely of heavy metals, which are highly polluting and can not be disposed of without adequate treatment. This paper presents an already successful and successful case study of a renowned company located in the PIM - Manaus industrial pole, pointing out an economically viable alternative, with support in the available technologies and meeting the requirements of the applicable laws, as well as describing the whole learning process in the course of activities.

Keywords— Synthetic oils, Destination, Liquid waste, Applicable law requirements.

I. INTRODUCTION

The continuous and constant disregard for the environment by the human being, either individually or through highly polluting productive processes, is increasingly evident as one of the greatest threats to the renewal of existing natural resources, especially water resources and, for that matter, continuity of life. Through this reality, urgent measures need to be taken to minimize the inconsequential use of natural resources and favoring sustainable development, ensuring the proper use of these resources without jeopardizing the progress or danger to the continuity of the human race.

Among all available natural resources, water is undoubtedly the most important element for the continuity of our species on the planet. Debates on preservation and conservation of water resources and on the environmental issue are a reality, being part of the agenda of major sanitation companies and government agencies in general. The study of water, its composition, availability and scarcity in some areas, is the subject of several pedagogical projects related to environmental education.

Machining is the operation that gives the part: shape, dimensions or surface finish, or a combination of these, through the removal of material in the form of chips [1].

In this sense, it is sought through this case study, to demonstrate how the effects of the application of liquid

waste treatment to the reduction of the cost of production in machining processes in a company of our Industrial Pole of Manaus, from the obtaining of water in nature until its processing and return to the receiving body or other uses, such as reuse processes.

II. BIBLIOGRAPHIC REFERENCE

In the available literature, there are several concepts, ranging from author to author. According to [2], there are many different names and they designate the same substance (oil or cutting fluid), making it difficult to discern the performance of each one in the process in which it is applied. If it is necessary to standardize this nomenclature for the correct distinction of its individual characteristics and applicability.

Another application, [3] addresses the Technological Aspects of dry machining with minimal amount of cutting fluid.

2.1 Synthetic Oils and Cutting Fluids

We will use the following concepts:

Cutting fluid - It is said about any fluid used for the cutting or machining of metals or other materials [4].

Cutting oil - It can be originated as mineral (petroleum), animal or vegetal, pure or associated [2] and is used as a supply, with no mixing with water, also called pure or integral [4].

Emulsifiable oil - It is a cutting fluid based on mineral oil mixed with emulsifying agents [2], its use is mixed with water in the form of an emulsion, at any oil content [4]. Usually called water-soluble oil or emulsifiable cutting fluid [2].

Synthetic fluid - Also known as chemical fluid. Refers to the chemical solution composed of inorganic materials and / or other materials dissolved in the water and which does not contain mineral oil [2].

Semi-synthetic fluid - Commonly found as a semi-chemical fluid, it is a cutting fluid containing a small part of mineral oil mixed in water, forming a fine emulsion, similar to a common solution [4]. It can be said that it is a combination of the synthetic fluid with a very small part of emulsifiable oil with a high emulsifier content [2].

It can be said that synthetic cutting oils or cutting fluids are extremely complex compositions found in large-scale machining processes, whose structure of chemical agents will depend on the production dynamics and the metals with which they will be worked [1], as well as to the environment [5].

This project gains significance to the extent that the identification of research objects in liquid waste disposal can contribute to standardize and obtain references on the authentication of the research in the scenario in which it is proposed. It is known that due to the interdisciplinarity, characteristic of research in contemporary society, scientific production is often dispersed in publications of various fields and not only in the publications of the area.

Some factors are considered as delimiters for this research: first refers to the constant cycle of technological development that makes the methodologies applied to the treatment of liquid waste and an infinite range of other processes, obsolete every second. Besides addressing topics that, due to their interdisciplinarity, are inserted in the most diverse areas of scientific production. Secondly, it will be important to consider the fact that Portuguese is not the language commonly found in international research, causing arduous work to develop search strategies, as well as the correct and strict interpretation of data collected

2.2 Water as a Primal Resource for the Machining Process

Some preliminary information is relevant to the understanding of what is proposed in the article. In the world, according to statistics provided by the WHO (World Health Organization) and published by Marcos Von Sperling, in his book "Introduction to Water Quality

and Sewage Treatment", water is distributed as follows, in the world sea water : 97%; Glaciers: 2.2%; Freshwater: 0.8% groundwater: 97%, Surface water: 3%.

Man's interference, either directly or indirectly, such as the use of organic waste in the soil, contributes to the introduction of new elements that alter the quality of this precious liquid in nature.

In industry, the versatility of water, due to its property as a solvent and its ability to transport particles, among a multitude of uses, makes it a fundamental resource for good process progress.

Therefore, especially in industries, understanding all the relevance of this resource for sustaining processes, and for economic or even cultural issues and in the face of an aggressive immediacy imposed by technological advances, we are constantly seeking ways to reuse this resource, recycling processes, investing in reuse methods, increasingly effective and in awareness campaigns aiming at the maximum extension of the useful life and the reduction of the cost of manufacture. The importance of the treatment and the consequent destination, economically viable, according to the parameters of sustainability, becomes even more evident if we take into account the recent events related to the climatic and water crises in the planet.

2.3 Viable Environmental Alternative

Placing as the main topic of discussion the concept or idea of sustainable treatment and showing how it can directly affect how humans and companies currently dispose of natural resources and dispose of waste can be a crucial point in how the dynamics of natural resources is treated in the most diverse fields. discuss the consequences of misuse of this resource and its link with rational consumption reverberates directly in the establishment of sustainable industrial actions.

In this way, companies expand their horizons on sustainable competitiveness, without depleting resources and reducing markets, bringing benefits to society, reducing pollutants released, either in the atmosphere or in receiving bodies and minimizing the harmful impacts of productive activity on the environment. Communities as a whole, industries, markets, as well as governments can be favored over the discussion of sustainable treatment and its effects. However, issues related to sustainability are urgent and need to be the focus of the discussion, such as social, economic and social entrepreneurship, and can, in the short and medium term, cause resource depletion, political backwardness regarding incentives for technological development and to

the research, being the commitment of the very survival of some of the specific social groups.

The scientific production aims, in a clear way, to harmonize the knowledge acquired in the research sphere with reality, in order to optimize its analysis and, consequently, to produce transformations. The impact of the systematic adoption of the appropriate and environmentally correct treatment of this precious resource, consists of a very relevant practical effect, is of particular importance in reducing the costs of production and destination in industries.

III. METHODOLOGY

For a correct and efficient data analysis, we made use of quality tools considered essential to the project: Brainstorming, Histogram, Pareto Diagram and Ishikawa Diagram.

3.1 Quality Tools Used

a) Brainstorming. The brainstorm is a term coined by Alex Osborn in 1953 [6], brainstorming or brainstorming session is carried out in a group consisting of a leader and about five regular members and five other guests. Regular members serve to keep pace with the process, and five other guests can be experts [7].

What is important in this method is that ideas flow spontaneously and "without brakes" or pre-judgments.

b) Histogram. "It's a very important quality tool for statistical analysis. It is a graph that shows the distribution of recorded events across the spectrum. These recorded events are called samples and are data collected from a process that wants to analyze behavior [8].

c) Pareto diagram. "Also known as Rule 80/20, Curve ABC or even Pareto Diagram, Pareto Analysis is a scheme, usually in the form of a column chart, that groups and orders the frequency of certain occurrences. Everything is done based on a very simple idea: that 80% of the consequences come from 20% of the causes [8].

d) Ishikawa diagram. "The Ishikawa diagram, of fishbone, of cause and effect or 6M, helps managers to investigate causes of problems for further resolution. The method is to organize causes into groups - labor, environment, materials, machines, measurement and methods - and study their effects [9].

3.2 Emergency Vulnerabilities

In the case of a case study of a project already implemented and successful in a renowned company, located in the Industrial Pole of Manaus, it was necessary to carry out the study on the emergency vulnerabilities at

the time and the feasibility in the treatment of each one, hence, opt for the most relevant.

The entire discussion, illustrative figure 1, focused on the environmental equipment of responsibility and operation of the Utilities Sector of that company, where based on the data collected from official documents, such as monthly costs, quarterly costs, annual costs, operational quantitative, environmental liabilities, the destination of the waste and etc., it was possible to reach the object to which this article refers.

The performance of the following equipments was evaluated through brainstorm:

- Boiler House; • Power Generator;
- Effluent Treatment Station: in particular, we include liquid waste from the company's entire cooling network composed of more cooling towers, cold water plants and wells;
- Incineration Plant: here it is only the process that uses the liquid waste incinerator, since this, as we will see later, corresponds to the higher demand of this equipment.

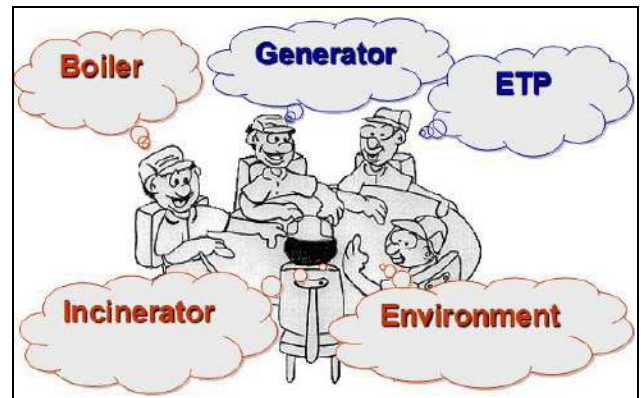


Fig. 1: Evaluation of the cost of environmental equipment

It was verified that the Boiler House and Incineration Plant were the equipment that demanded the highest monthly cost for the maintenance of its infrastructure and it was decided to dissect the reasons why this was a reality.

Some conclusions have been reached about which vulnerability to address first.

Several factors have been taken into account, such as:

Technology available at the time; Supply of inputs; Local alternatives to the energy matrix used until then; Cost with fuel; Economic viability; Current legislation; Logistics.

Figure 2 shows the flow chart of the liquid and solid waste path from its source to the incineration plant.

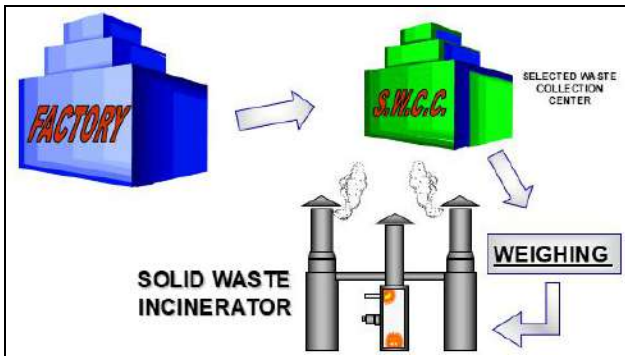


Fig. 2: Liquid waste flowchart

The liquid waste incinerator operates in the incineration of cutting oil (95.73%) and oil release agent (4.27%). It uses as fuel kerosene and has an incineration capacity of 1,000 liters per hour, at a working temperature ranging from 800 °C to 900 °C in a 13-hour work regime.

3.3 Comparison of costs of incineration SOLID X LIQUID

The graph of figure 3 shows the monthly average during the year of the cost of solid incineration x liquid.

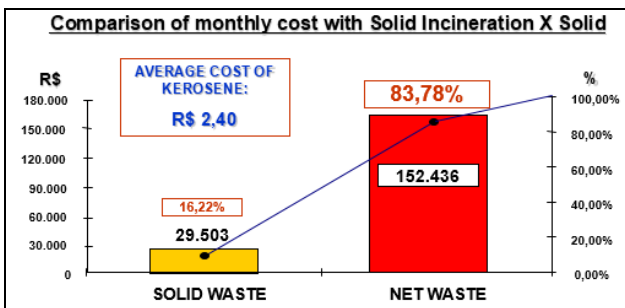


Fig. 3: Liquid waste flowchart

The average kerosene cost of 2.4 reais represented 16.225 of the total cost, while the cutting oil residue in the incineration process in question corresponds to 83.78% of the demand that came for processing.

With the available data, the decision analysis was made of which relevant vulnerability we would attack, within which the diagram of Ishikawa. Figure 4 shows the illustration of the Ishikawa diagram, where the environment, machine, methods, employee, cost and safety were analyzed.

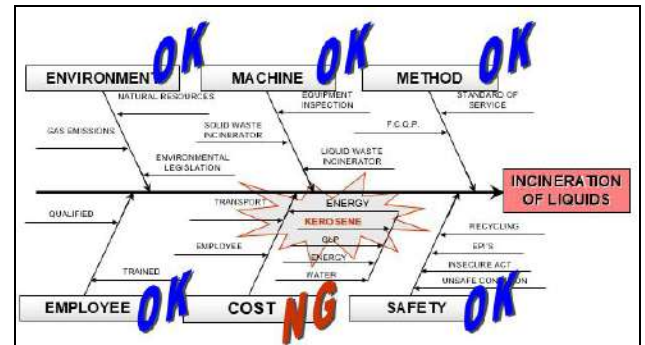


Fig. 4: Ishikawa diagram

As shown in Figure 4, the question of the energy matrix was the most urgent. It was necessary to reduce the cost with the consumption of kerosene.

Kerosene is one of the finest fossil fuels used in industry and, in addition to the generation of sulfur dioxide and carbon monoxide, still generates a huge amount of particulate matter and inevitably ends up reaching our atmosphere and causing, among other situations, health problems. "Studies point to several diseases caused by contamination of particulate matter, such as premature death of the heart, heart problems such as heart attacks and cardiac arrhythmia. There are also reports of development of asthma in children and other problems related to the respiratory system, such as irritation of the airways, coughing and difficulty breathing.

A detailed analysis of the cutting oil processing was made and the sampling was started in the sector where the operation occurred and the problem was identified as the quantity of contaminants present in the product, which made it unfeasible for reuse or recycling.

The contaminants in question were mostly: bush oil, microorganisms, filings, hydraulic oil, fabrics, polymer waste such as plastic pieces.

After analysis, it was concluded that the real cause of the high cost of incineration of the liquid residue (soluble oil) was in the large contaminated volume of this material, which was discarded.

We went to the research of: Current treatments for the product; Service providers (local or non-local); Economic viability of the project; Return on investment; Environmental legislation in force.



Fig. 5: Cutting oil operation

The machining process uses the cutting oil to perform the process. Figure 5 shows an illustration on the cutting process and the use of cutting oil.

3.4 Making Possible Solutions

The possible solutions of the problem are the decontamination of the cutting oil in the generating source; Decontamination through the physical-chemical treatment of the effluent treatment plant; Decontamination through the centrifugation process for disposal at the effluent treatment plant; Decontamination through the centrifugation process followed by ultrafiltration for disposal at the effluent treatment plant.

3.4.1 Decontamination of cutting oil at the generating source (machines)

As a fundamental part of the machining process, the use of cutting oil is shown in figure 6.



Fig. 6: Cutting machine oil operation

The options are:

a. Placement of screens at each outlet and oil in the equipment to contain contaminants. is economically viable and some machines already have output screens, but would only solve the problem of solid particles, such as filings. Discarded hypothesis;

b. Placing of rails for containment of the busbar oil. The buses were internal and the very systematics of the

processes caused drag of the contaminants. Discarded hypothesis;

c. Local sterilization of each equipment to avoid microbiological contamination by exposure and contact. Need of sterilization of all the machines, not only of the cutting oil coming from the reservoirs. As the environment was open, even sterilizing, the microbiological contamination would occur again. Hypothesis discarded.

3.4.2 Decontamination through the physical-chemical treatment of the ETS (Effluent Treatment Station)

The treatment of industrial effluents generates as by-products, the quantity and nature of the by-product depends on the characteristics of the initial effluent. Figure 7 shows a treatment plant



Fig. 7: Effluent treatment plant

The options are:

a. Critical variables of the above specified process: BOD (biochemical oxygen demand), COD (chemical oxygen demand). Discarded hypothesis;

b. Oils and greases of cutting oil above specified in relation to the effluent from the manufacturing process. Discarded hypothesis;

c. Death of the colonies of microorganisms essential for the treatment of the effluent. Discarded hypothesis;

d. Reducing the efficiency of the treatment process.

Hypothesis discarded.

3.4.3 Decontamination through the centrifugation process for disposal in the ETS (Effluent Treatment Station)

Centrifugation involves the removal of solid particles and part of the heavier oil by density difference. Figure 8 shows the spinning process.

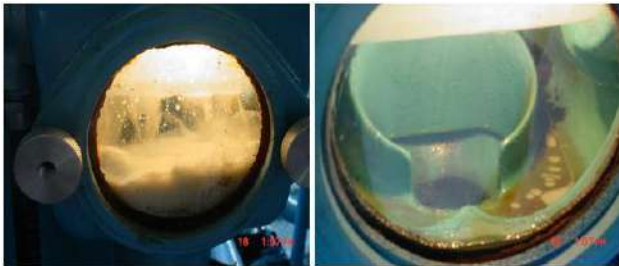


Fig. 8: Centrifugation process

The options are:

- a. There is withdrawal of solid particles and removal of the lubricating and bushing oil, but the cutting oil remains. Discarded hypothesis;
- b. Indexes of oils and greases, BOD, COD and heavy metals above that allowed in CONAMA 20/86, legislation in force at the time. Discarded hypothesis;
- c. Death of colonies of essential microorganisms when discarded for ETS. Discarded hypothesis;
- d. Reduction of the efficiency of the treatment process in the ETS. Hypothesis discarded.

3.4.3 Decontamination through the centrifugation process followed by ultrafiltration for disposal in the ETS

Ultrafiltration is the removal, at the molecular level, of particulate matter, colloidal, dissolved organic and microorganisms through the passage, through membranes, of the soluble oil, under high pressure and with low consumption of electric energy. Figure 9 shows an example of the result of the ultrafiltration process.



Fig. 9: Result of centrifugation followed by ultrafiltration

The options are:

- a. There was a cost reduction with the destination of the liquid waste;

b. There was withdrawal of solid particles and removal of hydraulic oil, bus and cut oil;

c. BOD, COD, heavy metals in accordance with the standards of receipt for treatment in TES.

The centrifugation method followed by ultrafiltration was what demonstrated greater energy efficiency and greater efficiency in meeting the current environmental standards.

IV. RESULTS OBTAINED

4.1 Analytical Result

The analytical results are based on the specifications of the National Environmental Council, created by Federal Law No. 6.938 / 81, which is the Brazilian collegiate body responsible for adopting measures of an advisory and deliberative nature regarding the National Environmental System. All specifications have met CONAMA.

4.2 Return on Investment

With the implementation of the process, the cost of incineration of the liquid waste, which was R \$ 0.80, was R\$ 0,35.

Figure 10 show reduction.

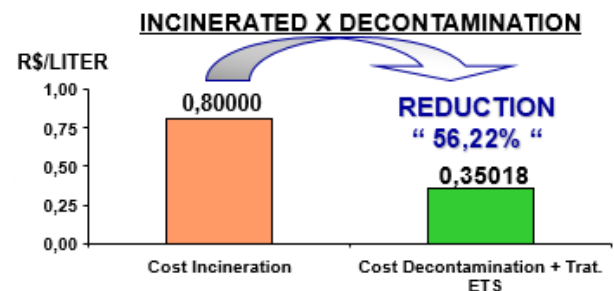


Fig. 10: Result reduction

Reduction of 56,22% of the cost of the destination of liquid residue and of 18,36% in cost with the "general" kerosene of the factory.

When applying the information to the consumption of kerosene x annual cost of the destination in the incineration plant, the very high number of R\$ 1,948,752.00 is reached during the period of one year.

V. CONCLUSION

The aim of this project was to demonstrate, in a structured way, the importance of an environmentally correct destination, endorsed by good practices, a constant maturation of environmental awareness combined with the technological advances essential to the maintenance of the environment, which makes industrial

production much more competitive and sustainable. In order to satisfy this purpose, a synthetic description of the solution found for optimization of the destination of the liquid residue generated in the machining process of the company in question was chosen.

The result obtained, exceeded expectations, brought with it an extensive and prolific attitude change in relation to the negotiations and possible environmental impacts resulting from the disposal of this material in an inadequate way, a considerable financial return, besides serving as an aid to future researches concerning the area.

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REFERENCES

- [1] MACHADO, Álisson Rocha et al. Teoria da usinagem dos materiais. 2009.
- [2] SILLIMAN, Jeffrey D. (Ed.). Cutting and grinding fluids: selection and application. Society of manufacturing engineers, 1992.
- [3] CASTRO, Pablo Ricardo Amarante de et al. Aspectos tecnológicos da usinagem a seco e com mínima quantidade de fluido de corte na furação com broca helicoidal. 2001.
- [4] RUNGE, Peter RF; DUARTE, Gilson N. Lubrificantes nas indústrias—produção, manutenção e controle. Ed. Triboconcept, Cotia, 1990.
- [5] ZEILMANN, Rodrigo P. et al. Processos de usinagem e responsabilidade ambiental através da redução da utilização de fluidos de corte. XVII Simpósio Internacional de Engenharia Automotiva, p. 16-17, 2009.
- [6] SELEME, Robson; STADLER, Humberto. Controle da qualidade: as ferramentas essenciais. Editora Ibpx, 2008.
- [7] BAXTER, Pamela; JACK, Susan. Qualitative case study methodology: Study design and implementation for novice researchers. The qualitative report, v. 13, n. 4, p. 544-559, 2008.
- [8] VIEIRA, Sonia. Estatística para a Qualidade. Elsevier Brasil, 2016.
- [9] RAMOS, Edson MLS; DE ALMEIDA, Silvia dos Santos; DOS REIS ARAÚJO, Adrilayne. Controle estatístico da qualidade. Bookman, 2013.

Optimization of the Production Process Layout of a Small Clothing Company

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Abstract— Companies seek improvement of results through the use of process analysis tools. The aim of this study was to analyze and structure the production process of a clothing manufacturing company, using methodologies such as PDCA and quality tools that aided in decision making, proposing changes to optimize the main indicators of the feasibility of each proposal with its cost-benefit.

Keywords— Process for making clothing, PDCA, Quality tools, Productivity indicator, Process layout.

I. INTRODUCTION

The production process models used today are influenced by several factors, among them the volume of demand and the variety of items to be produced, there may be hybrid models to serve different types of processes and causing companies to seek more and more by innovations to ensure competitiveness through the guarantee of quality and flexibility of its products.

Within the clothing industry, when analyzing the production process model historically, it can be assimilated to other branches, which began with artisan processes, producing by order and demand, evolving to linear processes of production, to meet high demands of the market, currently works with hybrid models, as exemplified by [1], in their studies aimed at structuring a productive process of a military garment manufacturing company, where a mixed physical arrangement was applied that depended on the stages of each process.

In order to analyze the process of the company in question, the PDCA methodology was used to better understand the production process, to prioritize the main causes and effects that are generating low index in the indicators and, finally, to define the action plan that will generate the best results for the company. The quality tools used in this methodology have the objective of bringing clarity to the work that is carried out in the process, helping in making decisions based on facts and data.

Regarding each study and analysis performed, one can better understand the process flow and decide which best

model can be deployed on the factory floor, as well as the improvements needed to ensure high productivity and production performance. According to [2], the positioning of facilities, machinery, equipment and production personnel are very important for the performance of a productive operation, whether in manufacturing, storage, service or office operations. In addition, the location of these items directly affects the ability of a company to compete 12wewithin the market.

II. BIBLIOGRAPHIC REFERENCES

The manufacturing industry requires a low level of technology and because its machinery is easy to handle, it is formed by medium and small companies, where these factories produce low value products in large scale and with cheap labor, where often, this branch can provide gains of scale in the stages of the productive process [3].

The company studied works specifically with the production of hospital clothes, where it seeks growth within the local market and in the state of Amazonas. Within its internal process, the company buys all the necessary inputs for the manufacture only of the process of cutting and sewing. That is, buy the fabric ready for the final product, and the same is responsible for the sales plan and storage of the same.

In this way, we can better understand the flowchart of the production process that begins with the receipt of the inputs, which is allocated in a separate stock for them, soon after the cuts are made in the materials and separation of the products that are defined through the plan of production generated by the management of the

company, after which all cut material is separated and passed on to the sewing and packaging process, and finally, the products are stocked waiting to be sold to the store. All this procedure is done in a handmade way and the company has 15 diversified sewing machines, 2 ironing boards and a cutting table as machinery, plus 6 seamstresses, two sewing aids and a cutter as an operational level collaborator.

2.1 PDCA Methodology

Before approaching the importance of the productive system model and process layout for the productivity results of the company in question, one must understand the steps used in the analysis and production solution (MASP) methodology and connect them to the PDCA cycle, to be able to understand their influence in the decision making made during the study. According to [4], any kind of decision is made in order to solve problems and avoid their recurrence, so these decisions must be based on data collected in the process, and analyzed by the sequence of the problem solving method. The following eight steps of MASP are described below according to each acronym in the PDCA cycle:

P - Plan

1) Identification of the problem. that through analysis of the process as a whole, where we will see not only the current situation or the bottleneck of the process, but also work on the prevention of possible incidents in the future.

2) Analysis of the Phenomenon, where through the generation of indicators we can see the real effect of what is happening in the process, understanding this effect, we can better understand the root cause and move towards a more assertive action plan (facilitate decision making by part of the board).

3) Critical Process Review that is in Failure. We will prioritize the bottlenecks to be treated trying to dismember it to arrive at the fundamental solution

4) Create a short-term action plan that has a large-scale effect.

D - Do

5) Execution of the action plan generated.

C - Check

6) Verification of the results obtained.

7) On top of these results we will check if the effect is sufficient or not, if a reanalysis is needed, we will include more actions in the plan

A - Act

8) And finally, when we arrive in a satisfactory state in relation to the expectations of the board, we will work in a process of standardization of all the processes to avoid that the effect happens again or to continue with the process of improvement.

2.2 Production Balancing

Production balancing is used to level the steps of a process as to its available resources, whether they are machines, people or inputs used, through the time, methods and volumes of each step. According to [6], balancing helps in defining all the activities that will be executed during the process to ensure that the execution time between the stations is the same. Balancing the production line is to define the set of activities that will be executed in order to guarantee an approximately equal processing time between the workstations [7]. The production line balancing is one of the techniques applied to improve the process and simplify the management [8]. In this way, through time analysis and availability calculations, resources can be used more efficiently within the process.

In the company in question, it was analyzed the times of the products that generate the greatest return to the company in search of a balance that could generate better production results.

2.3 Production Performance Indicators

Although the concept of productivity and efficiency are distinct, both are closely associated and can be applied in different branches of industry. For [9], the use of performance indicators is a good performance management practice that can and should be used. According to [10], a performance measurement system consists of a series of measures (or indicators) used to quantify the efficiency or effectiveness of a process.

In the study of [10], a distinction is made between quality and productivity indicators: the quality indicator is related to the measurement of the company's effectiveness in meeting the customers' needs, while the productivity indicator represents the efficiency of the process in obtaining expected results. The diversity in the interpretation between efficiency and productivity is basically the reflection between the various social actors existing within any organization is inserted. Being that, in this work, the concept of productivity is focused on the organization of work in production as the main instrument. Thus, this study was carried out inside the factory floor, where it was made a relation of what was produced with the resources used to produce or availability that had to perform the production [11].

Within this context, it had been defined that productivity is the result produced compared to the amount of labor used. The higher the production performed by the same number of employees, the higher the productivity index of the company.

2.4 Physical Arrangement and Process Layout

The physical arrangement of a company is extremely important for its performance indicators, as it will define how the human-machine interface will be in order to improve the flow of processes or impair the distribution of resources causing loss of production time. It is presented by [12], the concepts and classifications of layout and physical arrangement. For [13] the layout or physical arrangement consists of the positioning of the facilities, machines, equipment and operation personnel, in a productive operation, determining the flow of materials, information and customers.

According to [2], defining physical arrangement is deciding where to place the facilities, machinery, equipment and production personnel. This is because they are very important to the performance of a productive operation.

There are four types of physical arrangement [14], positional, product, process, and cellular. The positional layout is that the product is in fixed position and the operations are around the same, usually used in products of great size like ships, bridges and airplanes; the layout by product is defined to allow the linear flow of materials and assemblers in general use this type of physical arrangement, such as automobile production; the process layout is designed to accommodate a wide variety of designs and processing steps, such as in the machining area by lathes; and cell layout machines are grouped into cells that produce a particular family of parts with common features such as specific parts of the car assembly (glass, plastic injection, etc.).

According to [15], in order to define the best type of physical arrangement for the plant, it is necessary to understand the volume of production and the variety of items to be produced, and there may be hybrid models to serve different types of plants.

III. TOOLS AND METHODS

The proposed case study uses the PDCA and MASP methodology with the purpose of obtaining a study focused on the discovery of the main problems and their causes to then generate treatments that can generate results that are close to what was expected. Through these methodologies, several quality tools are used to analyze

the process in order to identify the best possible actions to implement improvements in the process.

The first step of the study is to analyze the process to understand how it works, in Table 1, you can identify each step of the process of making the company's clothing and an initial analysis of it.

Table 1. Stages of the production process and initial analysis.

Process Analysis	
Product ion plan	Passed by the board and still in the initial phase.
Stock of material receipt	Material allocated in deposit and separated by product code.
	Not yet implemented stock control.
Fabric Cutting	Amount of Material Based on Launch Production Plan.
	Uses molds received by the stylist and industrial cutting machine.
	Molds made of wood paper.
Sewing and finishing	Cutter draws the mold on one side of the fabric, then overlaps the amount of fabric defined in the plane.
	The cut fabrics are separated and identified with a brush, and are allocated in the input cabinet.
Finished product stock	3 sewing cells perform the complete sewing process without finishing, which is done by one of the collaborators at the end of production of the product. And an assistant passes the fabric before sewing.
	The cells divide the sewing process between them.
Finished product stock	Finished product is allocated in the room of the leader of production, according to layout presented, waiting to finish works in administration and in the store.

Analyzing the initial survey done by collecting data on visiting the site and understanding how the process works, we verified the need for a 5S in all stages, mainly regarding the sense of use and cleaning. This philosophy helps to keep the process organized, to avoid possible material exchange errors during a production, and to lose material in the process (wasting time). For example, use

color identification, set fabric storage location that has already been cut and is waiting to enter the sewing process, create stock picking control, set up post cleaning activity (leaving material available to employees), and a number of actions, can help avoid waste. Below are listed some essential elements listed in the analysis for the generation of immediate actions:

A) Stock of material input:

1- The identification of the inputs is being carried out, but only by model. Make stock reorganization by color and model to ensure that the product will not be confused if the order comes with some kind of error.

2- There is a need for material control to work with indicators of material waste, but there is no access to a computer system inside the factory to facilitate the control, so the control needs to be done in a handwritten way.

B) Production plan:

1- Creation of double-check (signature of two responsible in the order of production) to ensure that they passed through those responsible for the process and there is no rework or product stopped in stock.

C) Cutting:

1- Creation of copy of all the molds for paper harder, since they are being made in wood paper and already are wearing.

2 - Organization and local identification of storage of cutting inputs, since they are arranged in a disorganized way.

3- Organization and identification of the place of storage of product within the process. Cut fabrics are on all the benches, which can disappear or mix with other models.

D) Sewing and finishing:

1- Creating a place for products that are inside the process, because the products are folded on the table or in random basins.

2- Identification of the product model to be sewn to the show to facilitate when the seamstresses have doubts at some point. The goal is to accelerate the process of learning and solving doubts.

3 - Standardize a Quality Control, removing this responsibility from the production leader and passing to each operator.

4- Creation of management in sight identifying goals on the wall to encourage employees to reach them.

E) Stock finished products:

1- Definition of place of finished product inside the process, the same are arranged directly in the store or in the room of the leader of production.

After understanding the process and its peculiarities, a data survey was made to better understand the phenomena that were causing low index of results. To better analyze these phenomena, it is necessary to understand the expectation of the company that it was to have about a thousand pieces of clothing produced per month with the quota defined by the specialist in the production of clothing in atelier, however, it can be verified that there are a large gap between the expectation and the production realized in its first month of production according to Table 2.

Table 2. Analysis of the Phenomenon: Expectation of production versus actual produced.

Period	Production Expectation	Real Production
Monthly	1000 pcs	120 pcs
Daily	50 pcs	6 pcs
Diary per sewing cell	17 pcs	2 pcs
Production time per piece	30 min	270 min

Considering 9 hours of production per day, and 20 days per month, total of 180 hours per month.

By doing an analysis of production comparing the expectation with the realized, we see that the expectation asks us to perform 50 pieces daily in the plant, and the past period has made only 6 pieces (12% of the planned), and for the production to reach the expected quantity of 1000 pieces per month, she needs to produce one piece every 30 minutes or so, there is a difference of 240 minutes.

The main justification for this result of the first month of production are as follows:

1- Production training due to the refined cut style, where it is necessary to take into account the learning curve of the collaborators;

2- Adjust the molds and ready-made parts to leave them as requested, considering that they are new products.

3- Employees performing below expectations as they were trained by specialists before entering the process.

Thus, the analysis of the phenomenon makes us identify the actual capacity of the system, in hours, of production, according to Table 3, where: Installed Capacity is the total capacity of the system, Available Capacity is the time that operators have daily work (usually defined by the duration of the shift), Effective Capacity is the time that the operators work by taking the planned stopping hours and the Actual Capacity is the actual production time, considering the planned and unforeseen stops, as well as the pre-planning -defined to produce one piece every 30 minutes.

Table 3. Capacity of the Productive System.

Capacity	Month	Day
Capacity installed	480h	24h
Available Capacity	200h	10h
Effective Capacity	180h	9h
Real Capacity	21.6h	1.08h

With this data, we can calculate the efficiency of the system according to the initial planning of the system to have 1000 pieces produced per month, where we see that the actual capacity is 12% of the effective capacity, that is, the production had 12% efficiency in its first month, which indicates about 8 hours per day of production losses.

The company manufactures 10 different models in different colors and fabrics, and analyzing the production times, it is verified that the process of sewing and refinement of the piece is the most impacting in the productivity of the plant, where most models have the same time of production, differentiating in some smaller parts presented in Table 4. This table also presents the times for production of each piece according to the designer and the production leader.

According to production expectations, we have verified that it is necessary to produce about 1000 pieces per month. Analyzing the current production time only of the male overcoat, it is verified that it would need the 3 existing cells to close the production of 180 needed for the month only of that product, but it would not be possible to fulfill the plan of the other products, that is, the current capacity does not meet the requested monthly

plan. Thus, there is a need to insert three topics in the action plan of this study:

1- Production plan: definition of the plan according to the actual production capacity of each part.

2- Sewing process: Redefining the sewing process and finishing in order to increase the productivity of each piece.

3- Standardization of process: Definition of the time of production of each piece, new goals and standardization of the process by product.

Table 4. Time of production of the parts

Model	Production time	Daily production per station	Total daily production
Male Overcoat	3,5h	3	9
Female Overcoat 08	3,5h	3	9
Female Overcoat 09	3,5h	3	9
Female Overcoat 11	3,5h	3	9
Dress	2h	4	12
Female pants	1h	9	27
Female shirt	0,5h	18	56
Skirt	-	-	-
Male pants	-	-	-
Male shirt	-	-	-

Following the analysis of the data of the factory process of the company, we can still identify that the production system defined for the sewing process does not meet the requested capacity, as well as the physical arrangement of the factory shown in Figure 1. The layout of the machines and the warehouses disrupts the movement of employees and also increases the waste of time during production.

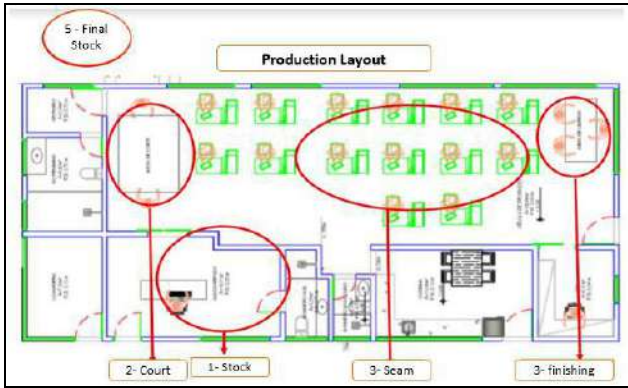


Fig. 1: Layout of the clothing company.

Through all the data obtained, one can identify the best actions in search of the expected results, and considering the needs pointed out so far, it was defined as a priority to structure the process by product type and based on this in the definition of this model, to define a better physical arrangement for the new process, thus identifying the process indicators that will assist in the periodic monitoring and evolution of the expected results.

The action plan was divided according to the schedule presented in Figure 2, where the first two steps are of studies and analysis of the process, and the rest are structuring and monitoring the results, in order to structure the proposed improvements and ensure that the expected results can be achieved.

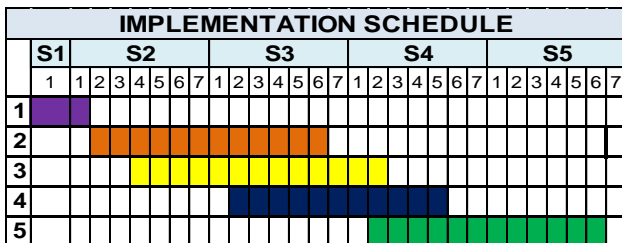


Fig. 2: Action plan.

- 1- Planning;
- 2- Process Analysis;
- 3- Process Structuring;
- 4- Process standardization and control;
- 5- Follow-up of the process.

IV. IMPLEMENTATION OF THE PROCESS

Through this proposed plan, activities were created focused on the structuring of all processes presented in figure 3.

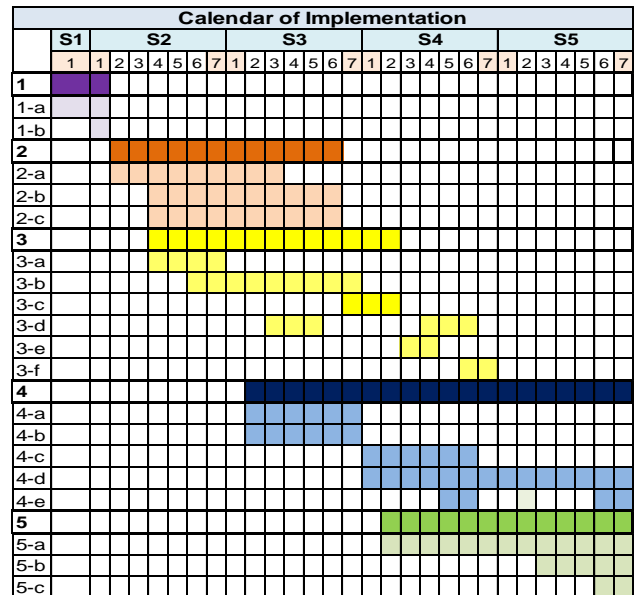


Fig. 3: Calendar of Implementation.

Figure 4 shows the description of the implementation calendar items

Implementation Calendar Activities	
Item	Description
1	Planning
1-a	Construction of micro activities schedule
1-b	Presentation of final schedule
2	Process Documentation
2-a	Definition of process documentation
2-b	Default Document Creation
2-c	Generate overcoat document
3	Process Structuring
3-a	Assemble updated layout sketch
3-b	Detail equipment layout
3-c	Make layout change
3-d	5S plan of the sewing process
3-e	Layout presentation to employees
3-f	5S training with employees
4	Process Indicator
4-a	Define indicators
4-b	Create process of daily productive control
4-c	Define tool for production management
4-d	Define index tracking method
4-e	Presentation of new process
5	Implementation monitoring
5-a	Follow-up of changes
5-b	Possible adaptations in the process
5-c	Final implementation presentation

Fig. 4: Description of the implementation calendar items

In the process analysis stage, the Process Documentation was defined, where it was possible to define and identify the processes by product. The main objective of this stage is to present to the employees how

they were doing and look for improvements in the procedures and methods used. Then the process documents were elaborated with Flowchart information, steps and activities of the process, as well as the chronoanalysis data was inserted per step, to facilitate the division of activities depending on the quantity of seamstresses available.

In order to define a better physical arrangement for this type of process, a study was made and the production time of the overcoats was analyzed, relating these data to the quantity of labor existing in the process. Figure 5 shows the flowchart adopted with the average times collected from each step defined by the Process Document, and through these time data, the calculated balancing was indicated to achieve better productivity results.

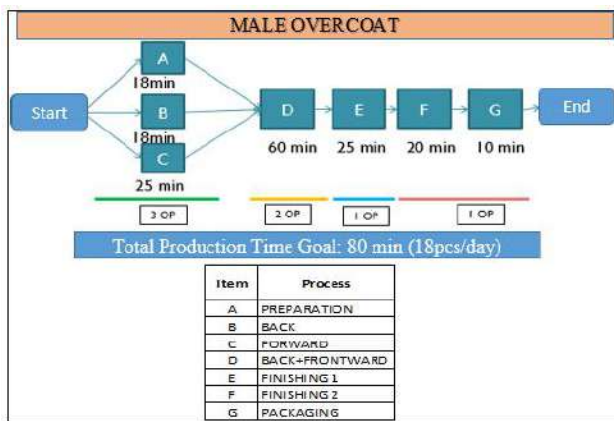


Fig. 5: Flowchart and Process Balancing

According to this balancing, the proposal would lead the company to produce about 20 overcoats a day. Therefore, this information was used to create the physical layout proposal for the plant, where the new physical positioning of the machines takes into account the movement of the seamstress by the process, the time of each stage and the specifications of the different products. In Figure 6 one can identify these points of improvement

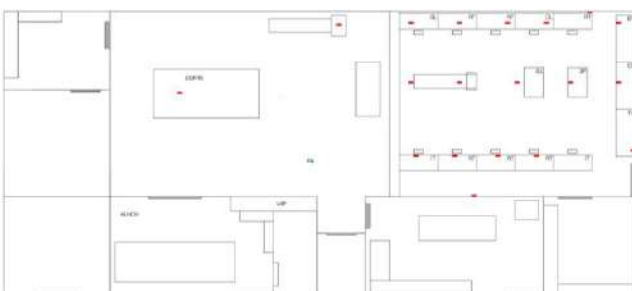


Fig. 6: New factory layout

In Figure 7 one can see the before and after the factory layout and the improvement in the process with regard to the movement between the process steps is visible, as well as the difference between the spaces between the workbenches, giving more room to organize the materials and tools used by employees



Fig. 7: Before and after the installation of the new Layout

With the structuring of the finished process, the identification of goals and creation of process indicators were performed, and the main ones to be followed are: Productivity, Efficiency and the number of failures found in the final product that need to be reworked, where all three need to be accompanied daily to be able to give vent to the improvements implemented and also check new opportunities in the current process.

A methodology model was used to follow up these indicators through the Excel tool, and in a Vista Management Framework implemented in the factory floor to facilitate the visualization of the goals by the operation. These tools are the most important tools that have been deployed for data collection and project progress analysis, where they will assist in the daily analysis of process results.

V. RESULTS

Through daily monitoring of the evolution of production results, it was possible to periodically stratify the results and work on the critical points that affect the process itself. Thus, in Figure 8, one can find the productivity result of March, where the studies began, until June, when the implementation actions were finalized. Through the data of this figure we can verify the effectiveness of the implemented actions, where there was a 200% evolution between the beginning of the studies carried out.

	Mac	Apr	Mai	Jun
Productivity	12	16	15	36
Production	120	160	151	360

Fig. 8: Productivity and Quantities of Produced Parts

In addition to the evolution in the company's productivity result, we can see a significant improvement

in the work environment generated by the change of layout of the factory floor, where production flow became clearer for all employees and the organization of the stages became more Figure 9 below. This improvement also helped the employees' satisfaction with the organization of the process, as well as the quality of the assembly and sewing process of the clothes.



Fig. 9: New factory layout

With the case study generating more than expected results, the standardization process was started to ensure that employees continued to carry out each stage and also had a basis for proposing improvements more objectively within their activities. Thus, all the data collected was documented, as well as all the standards of process aid documents.

VI CONCLUSION

This clothing company used a traditional ideology in its methodology of productive process, where the operators carried out the activities of artisan form. By applying the analysis tools in its production system, it was possible to identify improvement points in its process and a better use of the available resources, where as a result of these analyzes one can carry out the structuring of the sewing process, adaptation of the floor layout standardization of new procedures and creation of management tools to improve indicator controls.

The use of quality tools was of paramount importance, since it contributed to the decision-making and prioritization of the various demands that appeared throughout the analysis process, where we had the search for problem solving and also the search for improvement of the process. And through these tools and production balancing it was possible to identify the best floor layout for this process, where we improved both the productivity indicator, without the increase of fixed costs, as well as

improvements in quality assurance and ergonomics of the process as a whole.

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REFERENCES

- [1] DE OLIVEIRA, Adamo Henrique Rocha; TODARO, Mauro Enrique Carozzo. Arranjo físico do sistema produtivo de uma fábrica de uniformes. XXXIV ENEGEP. Curitiba, 2014
- [2] PENOF, D. G.; MELO, C. E.; LUDOVICO, N. Gestão de produção e logística. São Paulo: Saraiva, 2013.
- [3] BORTOLUZZI, Rafael. Análise do processo de produção de uma indústria de confecção por meio de simulação computacional: um estudo de caso. 2013. Trabalho de Conclusão de Curso. Universidade Tecnológica Federal do Paraná.
- [4] CAMPOS, Vicente Falconi. Gerenciamento da rotina do trabalho do dia-a-dia. INDG Tecnologia e Serviços, 2004.
- [5] CEPEDA, Norival Albergaria; MARTIN, Maria Aparecida Fernandes. MASP 1970-O PSICODRAMA. Editora Agora, 2010.
- [6] SHINGO, Shigeo. O sistema Toyota de produção. Bookman Editora, 1996.
- [7] TUBINO, Dalvio Ferrari. Planejamento e controle da produção: teoria e prática. Editora Atlas SA, 2007.
- [8] DEMBOGURSKI, Renan Augusto; OLIVEIRA, M.; NEUMANN, Clóvis. Balanceamento de Linha de Produção. XXVIII Encontro Nacional de Engenharia de Produção, Rio de Janeiro, 2008.
- [9] CARPINETTI, L. C. R. et al. Gestão da Qualidade ISO 9001:2008: princípios e requisitos. 3. ed. São Paulo: Atlas, 2010.
- [10] COSTA, Dayana Bastos. Diretrizes para concepção, implementação e uso de sistemas de indicadores de desempenho para empresas de construção civil. 2003. 176 f. Dissertação (Mestrado) – Programa de Pós-Graduação em Engenharia Civil, Universidade Federal do Rio Grande do Sul, Porto Alegre, 2003.
- [11] NIGRO, Idamar Sidnei Cobiانchi. Refletindo sobre Produtividade. XII SIMPEP. Bauru, 2015.
- [12] NEUMANN, CLÓVIS; SCALICE, Regis. Projeto de Fábrica e Layout. Elsevier Brasil, 2016.
- [13] SLACK, Nigel et al. Administração da produção. São Paulo: Atlas, 2015.
- [14] CHIAVENATO, Idalberto. Administração da produção: uma abordagem introdutória. Elsevier Brasil, 2013.
- [15] PEINADO, Jurandir; GRAEML, Alexandre Reis. Administração da produção. Operações industriais e de serviços. Unicenp, 2007.

Germination and Dormitory in Jatobá Seeds

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Abstract— Considering the difficulties to obtain seeds of good physiological quality and ideal techniques for the production of seedlings by seed, the objective of this study was to evaluate the germination of jatobá seeds, submitted to different methods of breaking dormancy. The research was carried out in the seed laboratory of the Federal Institute of Espírito Santo - Campus Santa Teresa. The experimental design was completely randomized, with four replicates of 50 seeds. The treatments were composed of seed immersion for 30 minutes in the following solutions: distilled water (23°C) (control), hot water (100°C), gibberellin solution 2000 mg.mL⁻¹, ice water (0°C), potassium chloride 50 g.L⁻¹ and coconut water. The following variables were evaluated: percentage of germination (G); germination speed index (IVG); time of germination (TMG). The treatment with coconut water presented the best indexes for jatobá seeds and the treatment with water 100 ° C impaired germination and was not recommended for jatobá seeds.

Keywords— gibberellin, coconut water, treatments.

Resumo— Considerando às dificuldades para obtenção de sementes de boa qualidade fisiológica e de técnicas ideais para a produção de mudas por semente, objetivou-se neste trabalho avaliar a germinação de sementes de jatobá, submetidas a diferentes métodos de quebra de dormência. A pesquisa foi realizada no laboratório de sementes do Instituto Federal do Espírito Santo - Campus Santa Teresa. O delineamento experimental utilizado foi o inteiramente casualizado, com quatro repetições de 50 sementes. Os tratamentos adotados foram compostos da imersão de sementes por 30 minutos nas seguintes soluções: água destilada (23°C) (testemunha), água quente (100°C), solução de giberelina 2000 mg.mL⁻¹, água com gelo (0°C), solução de cloreto de potássio 50 g.L⁻¹ e água de coco. Foram avaliadas as variáveis: porcentagem de germinação (G); índice de velocidade de germinação (IVG); tempo médio de germinação (TMG). O tratamento com água de coco apresentou os melhores índices para sementes de jatobá e o tratamento com água 100°C prejudicou a germinação, não sendo recomendado para sementes de jatobá.

Palavras chave— giberelina, água de coco, tratamentos.

I. INTRODUCTION

The Jatobá (*Hymenaea courbaril* var. *Stilbocarpa*) is a tree native to Brazil, also known as jataí. It is a large tree, which can reach 30 to 40 meters in height, and has a straight trunk up to 2 meters in diameter (or more than 5 meters of squeegee) and a thick bark of up to 3 centimeters (Shanley & Medina, 2005). Its origin is in the Amazon and kills the Brazilian Atlantic, being able to be found in large scale from Piauí to the North of Paraná. Its wood is used in construction and the furniture industry; being the fruits used in the food industry as well as the leaves and seeds used in the manufacture of cosmetics and medicines (Sousa et al., 2012).

The jatobá tree also has wide distribution in South America and Central America, from Mexico to Paraguay; is not seen

on a large scale being observed in a dispersed way in the upland forests and some high floodplains, more frequently in clayey and poor soils (Shanley & Medina, 2005)

The fruit is a brown pod, usually with two seeds. Inside, a yellowish pulp coats and protects the seeds. The fruit is very hardy and it is not easy to remove the seed from within, with a tegument popularly known as peel, which makes the protection of the embryo. These are employed in the food industry and the leaves and seeds in the pharmaceutical and cosmetic industry (Zuba Júnior et al., 2010).

As observed in this work, its germination is epigeous, phanero controlled, presenting an emergence of curved form, with germination beginning on the twentieth day after sowing. It has a great irregularity in the germination,

causing a great disomogeneity of the seedlings in the final formation of the seedlings, but with a low percentage of abnormal seedlings.

Seed dormancy refers to a state in which viable seeds do not germinate even when favorable conditions for germination are provided (Marcos Filho, 2015), an undesirable characteristic because it impedes germination, and dormancy techniques have to be used to obtain uniformity in seedling emergence (Andrade et al., 2010).

Among the main mechanisms of dormancy, water impermeability, inactive embryo and hormonal balance control the germination. Considering the existence of dormancy in Jatobá seeds, mechanisms of dormancy breaking to increase germination power should be tested for improvement of planting lots.

The seeds of the forest mainly suffer the phenomenon of dormancy due to the presence of inhibitory substances that act strongly, as well as impermeability of the integument and the condition of the embryo, being immature, rudimentary or dormant (Nesi et al., 2016). In the seeds of Jatobá (*Hymenaea courbaril*), usually dormancy is a function of a physical blockage found in the integument with presence of resistance to water entry and gas exchange, making embryo soaking and oxygenation difficult (Almeida et al. 2011).

Some seeds provided with hard and impermeable tegument can be prepared for sowing by heat treatment or by the use of products that can induce germination. The immersion of the seeds with pulp in boiling water can produce positive results. Several treatments can also produce favorable effects to the germination process of the seeds, since some substances have different levels of glucose, fructose and mineral salts, as well as plant hormones, inhibitors and promoters necessary for the germination process and seedling development.

Marcos Filho (2015) cites the importance of dormancy in seeds, from the point of view that it acts as a mechanism that prevents the germination of seeds when they present inadequate conditions for their development.

Freitas et al. (2013) cites the efficiency of the mechanical scarification of the jatobá seed as a method of breaking dormancy and increasing the percentage of germination and mean time of germination. In this way, it becomes important to study alternative methods to improve the germination of this seed.

The objective of this work was to evaluate the germination of Jatobá seeds, submitted to different methods of breaking dormancy.

II. MATERIAL AND METHODS

The research was carried out in the seed laboratory of the Federal Institute of Espírito Santo (IFES-Campus Santa Teresa), in the months of November and December of 2016.

In the experiment, seedlings, manually extracted from plants located in the institute region, were immersed for 30 minutes in the following treatments: distilled water (23°C), hot water (100°C), gibberellin solution 2000 mg.L-1, water with ice (0 ° C), 50 g L -1 potassiumchloride solution and coconut water.

The seed handling table was sterilized with 70% alcohol in which four replicates of 50 seeds were used for each treatment, seeded on two sheets of germitest paper under the seeds and one leaf on the seeds for each treatment, moistened with distilled water equivalent to 2.5 times the dry paper weight, and placed in BOD germinator with temperature stabilized at 25°C and light 16/8 hours.

The following variables were evaluated: percentage of germination (G); germination speed index (IVG); time of germination (TMG).

The germination test was conducted according to the Rules for Seed Analysis (Brazil, 2009), and considering the lack of data on the days for the seed count, counting was used from the start of germination up to 30 days after the first seed germinates.

The experimental data were submitted to analysis of variance, taking into account the assumptions of the model by the Shapiro-Wilk test to verify normality and the means of the treatments were compared by the Tukey test at a 5% probability level.

III. RESULTS

The treatment with coconut water obtained the best results for germination of Jatobá (63%), followed by gibberellin (58%), KCl (50%) and ice (48%), with significant difference between treatments. It is observed that the control had low germination (30%), proving the existence of dormancy in these seeds. The treatment with hot water obtained only 9% of germination (Table 1). This result for boiling water may have occurred probably due to the deterioration of the seeds at that temperature.

Table 1 - Germination in jatobá seeds submitted to different treatments

Treatments	G (%)	IVG	TMG
Pure Water	30 d	0,3590 b	22,3225 a
Water (100°C)	9 e	0,1072 c	22,4375 a
Ice (0°C)	48 c	0,5160 ab	24,0775 a
GA3 (2000 mg.L ⁻¹)	58 b	0,6180 a	24,1667 a
Coconut Water	63 a	0,7003 a	22,3125 a
KCl (50 g.L ⁻¹)	50 c	0,4963 ab	25,7907 a
CV (%)	21,31	23,08	14,53

Averages followed by the same letter in the column, for each variable, do not differ among themselves by the Tukey test at 5% probability.

Although no significant difference was observed in the treatments between treatments, coconut water presented the best results, and the same can be observed for IVG with statistical difference for pure water and water at 100 ° C, but with no difference for the others treatments but presenting the highest values.

IV. DISCUSSION

Several works have been performed to break dormancy in different seed varieties, however no work has been observed using coconut water, making this product appear as a research option for breaking dormancy.

Freitas et al. (2013), obtained low rates of emergence for *Hymenaea courbaril* var. *stilbocarpa* without treatment (11%), and with mechanical scarification obtained 53% of emergency and treatment with sulfuric acid at different times obtained 50% as the best emergency. These data confirm the existence of dormancy in Jatobá seeds.

Busatto et al. (2013) obtained in Jatobá seeds, only 6.67% of germination in the control, but it obtained good results with chemical scarification in 80% sulfuric acid, germination and mechanical chiseling of the integument with 60% germination. These two treatments allowed, in the period of time used in the study, germination statistically superior to the control, in which the seeds did not undergo any treatment to overcome dormancy. The immersion of the jatobá seeds in water at 90 ° C for ten minutes did not obtain germination corroborating with the results of this research that obtained only 9% of germination in this treatment.

Nesi et al. (2016) obtained after 150 days in the treatment with immersion in water at 90 ° C, 56% of twinning, but 2.67% started germination and died, and with scarification and subsequent immersion in 24 hours water, obtained 85 , 33% of total twinning and 5.34% started germination and died. Pagliarini (2012) using the same treatment with scarification and subsequent immersion in water 24 hours, obtained 68.8% of germination.

Busatto et al. (2013) consider that the contradictions found may be species specific, as well as other factors such as the time of collection, the stage of maturation of the seeds, the origin, the temperature and the period of immersion. One of the functions of boiling water in breaking dormancy is to increase the permeability of the integument, breaking the impermeable barrier, is considered a low cost method and with good practicality when applied in high scale, citing the need for other experiments with different water temperatures and time of exposure of the seeds to better respond on this treatment in Jatobá seeds.

The coconut has 93% water, 5% sugars, as well as proteins, vitamins and minerals, constituting a low calorie drink (average 20 calories / 100 mL), pH varying with fruit age. At 5 months pH is around 4.8, reaching over 5 until the end of fruit growth, whereas its water represents 25% of fruit weight (Aragão et al., 2001). During the fruit maturation process, some modifications are observed, with potassium being the nutrient that appears in greater quantity during maturation, sodium, calcium, magnesium, chloride, iron and copper are stable and the sulfur has a slow increase (Aragão et al., 2001). Coconut water is considered a great hydroelectrolytic repository, with similar action to commercial drinks with isotonic action and considerable mineral salts, besides being a natural product,, (Brito, 2004).

The isotonic action of coconut water and the presence of cytokinin can be considered a positive characteristic in its absorption and by the seed, increasing its germination capacity. It was used in popular culture as a substitute for water, and also to replace electrolytes in cases of dehydration (Aragão et al., 2001), the salts in coconut water may have acted preponderantly for this treatment to have achieved the best results. According to Sousa et al. (2005), the minerals Ca, Mg, Mn, Fe, Zn and Cu can be found in addition to Na and K in the mineral composition of bottled coconut water. The potassium salts reached 162 mg.100mL⁻¹ (Teixeira, 2018), which probably acted as a germination inducer, reaching the rate of 63% as seen in Table 1.

Besides the mentioned components, it also has citric acid and malic acid (Aroucha et al., 2010), which determine the pH of the water, being between 5.1 and 5.2 (Aroucha et al., 2014). Acidity is important as it is used as a sensory indicator for its role in taste and aroma (Charlo et al., 2009).

Similar to that found by Carvalho et al. (2018), the characteristics of coconut water may have been positive for the increase of germination, according to the results found in this research, placing this product as a further option of induction of germination and breakage of seed dormancy.

V. CONCLUSION

The treatment with coconut water presented the best results for germination of jatobá seeds.

The treatment with coconut water and gibberellin 2000 mg.L⁻¹, produced positive effects for the evaluated characteristics, being recommended for breaking dormancy in jatobá seeds.

Treatment with 100 ° C water impaired germination and was not recommended for jatobá seeds.

REFERENCES

- [1] ALMEIDA, M. B. et al. Descrição morfológica do fruto e semente do Jatobá (*Hymenaea courbaril* L.). **Revista Semiárido De Visu**. V.1, p.107-115, 2011.
- [2] ANDRADE, L. A. et al. Aspectos biométricos de frutos e sementes, grau de umidade e superação de dormência de Jatobá. **Acta Scientiarum**. v.32, p.293-299, 2010.
- [3] ARAGÃO, W. M. et al. O. **Água de coco**. Série Documentos 24, Aracaju: Embrapa CPATC/ Tabuleiros Costeiros, 2001.
- [4] AROUCHA, E. M. M. et al. Acidez em frutas e hortaliças. **Revista Verde de Agroecologia**, v.5, n.2, p. 01-04, 2010.
- [5] AROUCHA, E. M. M. et al. Análise físico-química e sensorial de água-de-coco em função de estágio de maturação das cultivares de coco anão verde e vermelho. **Agropecuária Científica no Semi-Árido**, Campina Grande, v.10, n.1, p 33-38, 2014.
- [6] Brasil. Ministério da Agricultura. **Regras para análise de sementes**. Brasília, 2009. 398 p.
- [7] BRITO, I. P. **Caracterização e aproveitamento da água de coco seco na produção de bebidas**. Dissertação de Mestrado. UFPE, 2004.
- [8] BUSATTO, P. C.; NUNES, A. S.; COLMAN, B. A.; MASSON, G. L. Superação de dormência em sementes de jatobá (*Hymenaeacourbaril* L.). **Revista Verde**, Mossoró, v. 8, n. 1, p. 154-160, 2013.
- [9] CARVALHO, S. P. et al. Tratamento nutricional na emergência de plântulas de romãzeira. 29ª Semana Agrônômica do CCAE/UFES - SEAGRO, **Anais...**, Alegre, 2018.
- [10] CHARLO, H. C. O. et al. Desempenho de híbridos de melão-rendilhado cultivados em Substrato. **Revista Científica**, v.37, n.1, p.16 – 21, 2009.
- [11] FREITAS, A. R. et al. Superação da dormência de sementes de jatobá. **Pesquisa florestal brasileira**, Colombo, v. 33, n. 73, p. 85-90, 2013.
- [12] MARCOS FILHO, J. **Fisiologia de sementes de plantas cultivadas**. 2ª ed, Londrina: Abrates, 2015, 660p.
- [13] NESI, C. N. et al. Superação de dormência em sementes de Jatobá avaliadas por análise de sobrevivência **Revista de Ciências Agroveterinárias**, Lages, v.15, n.1, 2016.
- [14] PAGLIARINI, M. K. **Germinação de sementes, adubação e níveis de sombreamento no desenvolvimento de mudas de jatobá (*Hymenaea courbaril* L. var. *Stilbocarpa*)**. 2012. 96 f. Dissertação (mestrado) - Universidade Estadual Paulista, Faculdade de Engenharia de Ilha Solteira, 2012.
- [15] SHANLEY, P.; MEDINA, G. **Frutíferas e plantas úteis na vida amazônica**, Jaqobá. 109-118, 2005. 300 p.
- [16] SOUSA, R. A. et al. Determination of metals in bottled coconut water using an inductively coupled plasma optical emission spectrometer. **Journal of Food Composition and Analysis**, Orlando, v.18, p.399-408, 2005.
- [17] SOUSA, E. P. et al. **Caracterização físico-química da polpa farinácea e semente do jatobá**. Revista Verde, Mossoró – RN, v. 7, n. 2, p. 117-121, 2012.
- [18] TEIXEIRA, N. S. **Aproveitamento do Albúmen Sólido do Coco Verde para Obtenção de Smoothie de Frutas Tropicais**. Instituto de tecnologia programa de pós-graduação em ciência e tecnologia de alimentos, UFRRJ, dissertação, 2018.
- [19] ZUBA JUNIOR, G. R.; FERNANDES, L. A.; ALVARENGA, I. C. A. Crescimento do jatobá e de leguminosas arbóreas em diferentes espaçamentos, em área degradada. **Revista Caatinga**, Mossoró, v. 23, n. 4, p. 63-68, 2010.

The Virtual Power Plant for the Management and Control of Distributed Generation - Review

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Abstract—The significant increase in the insertion of distributed generation in the electric power systems when carried out in a disorderly manner can cause disruption to the electric power system. In this sense, Virtual Power Plants (VPP) are presented as a solution to ensure, through a power management system, the best control actions to integrate the generation and demand pattern of each generating unit. Thus, this paper presents a literature review on VPP, introducing concepts, definitions, topologies, communication technologies used, and finally presenting the advantages and disadvantages on this topic.

Keywords—Virtual Power Plant, Renewable Energy, Microgrid, Distributed Generation.

I. INTRODUCTION

Distributed generation is seen by many as a solution to meet the growing demand for electricity. However, the insertion of distributed energy resources in the electrical system, when carried out in a disorderly way can cause some complications, for example: increase in power losses in the network, unreliable operation of protection devices, undesired voltage profile and an imbalance between actual energy consumption and production [1]. In this sense, one way to avoid such complications is through the management of distributed generation units.

This management requires a robust control system since the distributed generation units are configured in a topology so that the Electrical System "sees" this set as a single entity. This configuration is called Virtual Power Plant. This topology results in operational changes in the electric power system, where the network ceases to act as purely passive (unidirectional energy flow - from high to low voltage) and acts as an active network (with multidirectional energy flow) [2]. The generation and demand management activities are carried out by an Energy Management System - EMS, and its activities are performed by sending signals that control the generation and demand pattern for each generating unit, consumption unit or any other assets belonging to the network, such as reclosers and LTCs (Load Tap Changers) [3].

This paper aims to carry out a literature review on VPP, presenting definitions, concepts, topologies, technologies used in its implementation, benefits to the electric system among other factors relevant to the topic.

To carry out the bibliographic survey for the paper, the ProKnow-C methodology was used, analyzing the Scopus and Web of Science databases, for the survey of papers the key words were used: "Virtual power plant", "Review", "Framework", "Decentralized Energy Management System", "Distributed Energy Management System", "Distributed Generation", "Renewable Energy Resources", "Power Energy Resources" e "Microgrid", the combination of keywords in search engines resulted in 2191 papers, when selected we obtained a portfolio of 35 to elaborate this document.

II. VIRTUAL POWER PLANT (VPP)

A. Definition of Virtual Power Plant

Because it is an element of recent implementation and still in the development stage, VPP does not have a literary definition yet, which is why some definitions found in the literature are presented below.

In [4], the author defines VPP as systems that use load management software and energy storage systems. They are groups composed of distributed generators, where the generation is carried out mainly by sustainable sources, battery systems and "active" consumers that use load

management systems. He also says that the group should be controlled remotely by an EMS which manages the system ideally, depending on the energy demand, weather situation and storage capacity.

The VPP is also defined as a flexible representation of a portfolio of DER. It not only aggregates the capacity of several DERs, but also creates from a composition of parameters characteristic of each DER a unique operational profile, although it is composed of several technologies and several operational standards [2].

In [5] VPP is defined as the combination of different types of energy generation, renewable and non-renewable and storage devices, so as to appear in the energy market as a generating plant with a defined hourly output.

It is possible to notice that, although there are differences between the presented definitions, there is a consensus that a VPP is a group of DERs with different technologies in order to operate as a virtual power generation plant capable of controlling the aggregate units, managing the flow of electricity between them and obtaining the best operation for the system [1].

B. Concept of Virtual Power Plant

Formally, a VPP can be conceptualized as a group of distributed generators, flexible loads, and energy storage equipment that are grouped together for the purpose of operating as a single entity, as presented in Fig. 1: Virtual Power Plan Concept [6].

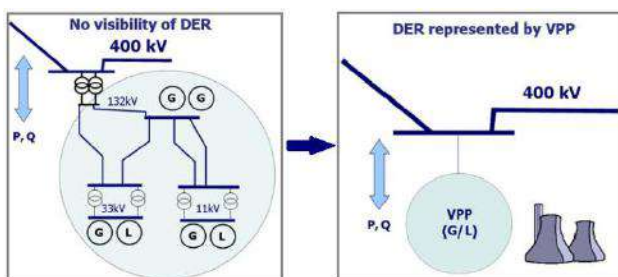


Fig. 1: Virtual Power Plan Concept [6].

Generating units in the VPP may use fossil or renewable energy sources. The objective of a VPP is to coordinate the production of the units that compose it in order to maximize its performance [7]. In this sense, [8] states that the main part of a VPP is the EMS, which is responsible for coordinating the flow of energy from the plants, as well as the management of controllable loads and batteries. In this way, with the active network, the VPP not only receives information of the current state of each unit connected to it, but also sends control signals to these units [9].

The exchange of information between the EMS, the generating units and the plants (mainly the intermittent ones, wind and photovoltaic), allows the EMS to operate according to specific objectives. For example, by acting on power flow control you can: Minimize operating costs, Increased reliability of power supply, Minimize losses caused by technical errors, Demand control and Planning, operation and supervision of the energy distribution process.

In addition, in order to obtain a process of optimization of the operation, information about the probable points of network overload is essential. This set of information allows the EMS to define the optimal mode of operation for each particular system [9].

In some countries the VPP is in operation, for example: Germany, Denmark, Spain and England are participants of the Fenix Project started in 2006 [10], the Netherlands has been running the City Zen Project in the city of Amsterdam since 2016 [11], France [12][13] and China[14].

III. STUDY OF THE TECHNOLOGIES - VPP

According to [1] [9] [8] and [15] the VPP can be divided into three technological components, being these: (i) Distributed generation, (ii) Energy Storage Systems and (iii) Information and communication technology. This chapter will now detail this division.

C. Distributed Generation

There are several considerations regarding the definition of distributed generation, so that those presented in the literature are not consistent [16], however, the authors usually agree that "Distributed Generation is a generation plant directly connected to the grid at the distribution voltage level or at the client side" [17].

The input of distributed generation into the system represents, depending on the system, considerable positive impacts on power flow and voltage levels. For example [16]: Loss reduction; Increased system reliability; Investments in new transmission and distribution infrastructure are dispensable; Quick and easy installation of standardized and pre-fabricated components and Reduced costs, since high-voltage power transmission over long distances is avoided. The Table 1. Most used technologies in GD [18].

The Table 1 shows the most commonly used technologies in distributed generation (DG) are presented and their typical power per module [18].

Table 1. Most used technologies in GD [18].

Technology	Power available per module
Combined Cycle Gas Turbine	35 - 400 MW
Internal combustion engines	5 kW - 10 MW
Turbine combustion	1 - 250 MW
Micro-Turbines	35 kW - 1 MW
Fuel Cells, Phosphoric Acid	200 kW - 2 MW
Fuel cells, Molten Carbonate	250 kW - 2 MW
Fuel cells, Proton Exchange	1 - 250 kW
Fuel cells, Solid Oxide	250 kW - 5 MW
Battery Storage	500 kW - 5 MW
Small Hydro	1 - 100 MW
Micro Hydro	25 kW - 1 MW
Wind turbine	200 W - 3 MW
Photovoltaic Arrays (PV Arrays)	20 W - 100 kW
Solar thermal, Central Receiver	1 - 10 MW
Solar thermal, Lutz System	10 - 80 MW
Biomass Gasification	100 kW - 20 MW
Geothermal	5 - 100 MW
Ocean Energy	100 kW - 5 MW

The generation units can be divided into 2 groups [9]: (i) Distributed Home Generator (DHG): They are the generation units intended for use by individual users, such as households, businesses or industries. In this case, excess energy can be injected into the grid [9]; (ii) Public Distributed Generator (PDG): It distinguishes itself from the DHG, since they are generators whose purpose is to inject the energy produced in the network, and do not have an individual owner [9].

D. Energy Storage System (ESS)

Considering that the component generating units of a VPP are mostly renewable energy sources, energy storage systems contribute to attenuate the fluctuation of the frequency caused by the intermittent generation of sources, aiming at the delivery of high quality energy, controlling frequency, improving transmission line capacity, attenuating voltage fluctuations and improving power quality [19] [20].

Energy storage systems are classified based on the use of energy in a specific form, and can be categorized into [19]: Mechanical, Electrochemical, Chemical, Electric, Thermal and Hybrid.

In addition, two criteria are used to determine the type of storage system for each application: the nominal power of the system and the discharge time of the rated power. According to these criteria the ESS can be used for three applications [21]: (i) Energy quality: According to [21], the ESS are used for a short period of time, within a few seconds, so the most used technologies are supercapacitors, energy storage in magnetic superconductors and some battery types; (ii) Bridging Power: This application is used in the exchange of generation technologies, having as main objective to ensure the continuity of the energy supply. The most commonly used ESSs are supercapacitors and some battery technologies [21] and (iii) Power management: When used for this purpose the technologies that make up ESSs have high storage capacity, so the most appropriate technologies for this application are compressed air storage systems, hydrogen technologies and some types of batteries [21]. Some storage technologies are presented in [19].

Table 2. ESS, life cycle and efficiency [9].

Storage System	Life (cycles)	Efficiency (%)
Hydroelectric with pumping	75 years	70-80
Compressed air	40 years	-
Flow Batteries	1500 - 2500	75 - 85
Metal Oxide Batteries	100 - 200	50
Sodium sulfide battery	2000 - 3000	89
Other advanced batteries	500 - 1500	90 - 95
Lead Acid Batteries	300 - 1500	60 - 95
Supercapacitors	10000 1000000	- 93 - 98

E. Information and Communication Technology

As discussed earlier, when implemented a VPP involves the participation of several DERs in simultaneous operation, so the EMS, through bidirectional communication, requires the data of all the RSDs in real time, allowing the execution of actions to guarantee the reliability and stability to the members of the network. Therefore, information and communication technology is one of the main components in the design of a VPP, making necessary the analysis of some aspects that impact on the development, such as [22]: (i) Type and configuration of equipment in the system: since different equipment may require responses at different times, so that different communication and interface configurations are set up together with the bandwidth of

each communication channel; (ii) Type of connection required: It is determined by the number of DERs in the system and their physical location, directly influencing the volume of data traffic and system maintenance costs; and (iii) Type of control to be used: it can be centralized or decentralized and directly designates the communication structure of the system. Opting for a centralized system guarantees the system a unification and simplification of its components, since all the processes are executed by a single software, without significant complications with respect to operating conflicts. Decentralized communication systems guarantee the system a high rate of redundancy, since it allows the independent operation of each equipment.

It is noteworthy that although the VPP technology is recent, it uses consolidated communication technologies in automation systems and even power systems [22]. The communication infrastructure used takes into account the value available to the project and the location of the DERs. A basic division of the communication system defines two types of technologies that can be used: wired and wireless. Tab. 3 shows some technologies already used in the functioning VPP.

Table 3. Communication technologies used in VPP [22].

Wired	Wireless
Power Line Communication (PLC)	Satellite Communication
Twisted pair	Wireless Communication
Optical fiber	Cellular Communication

Wired technologies can be trivially distinguished, however wireless technologies require a more detailed approach to a more consolidated understanding of the subject. The following will present some of them.

Satellite Communication: is the transmission of signals between two points (transmitter and receiver) through satellites. In the process of data transmission is considered the modulation of the signal and sending from the transmitter, the signal is then received by the satellite, amplified and sent to the receiver on the ground. This technology is used for monitoring and remote control of substations [23].

Wireless Communication: There are several technologies, wireless for VPP applications, these technologies are divided into short or long range. Some examples of technologies that can be used in VPP are : ZigBee, Wireless Local Area Network (WLAN), Wireless Mesh e Z-Wave [23]. The Table 4 it is possible to

distinguish these technologies and the most recommended ones for each distance.

Table 4. Wireless technologies for VPP [23].

Technology	Protocol	Theoretical maximum transfer rate	Range of coverage
ZigBee	ZigBee	250 kbps	Up to 100 meters
	ZigBee Pro		Up to 1600 meters
WLAN	802.11x	2 - 600 Mbps	Up to 100 meters
Wireless mesh	Many (802.11, 802.15, 802.16)	Depends on protocol selected	Depends on the type of deployment
Z-Wave	Z-Wave	40 kbps	Up to 30 meters
WiMAX	802.16	75 Mbps	Up to 31 miles
	2G	14.4 kbps	
	2.5G	144 kbps	
	3G	2 Mbps	Up to 31 miles
	3.5G	14 Mbps	
Cellular	4G	100 Mbps	
	Internet satellite	1 Mbps	62 - 3728 miles

Cellular Communication: technology based on radio networks and therefore has a large number of transmitters, taking advantage of the frequency of radio waves to increase coverage and data transmission capacity. The division of cellular communication technology is available in the Table 4, as well as the transmission capacity and coverage area.

IV. TOPOLOGY OF CONTROL

Given the concept and defined the technologies used in VPP, it is possible to analyze the VPP with greater understanding. The Figure 2 presented a VPP scheme is presented, where it is possible to notice that all forms of energy are connected to VPP, by which they will also be controlled, so that specific control topologies are required for each level of freedom of the DER.

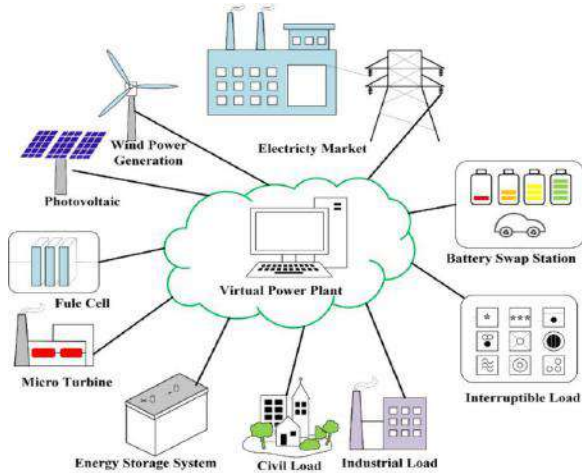


Fig. 2: Basic Elements in a Virtual Power Plant [24]

In [9], [8] and [15] two control topologies for VPP are pointed out: centralized and decentralized. However, it is also possible to find in the literature a third hierarchical control topology. All of these topologies will be explained below.

F. Virtual Power Plant – Centralized

In this VPP topology the DERs are controlled by a Control Coordination Center (CCC), which is strategically installed in the center of the DERs. This center is responsible for receiving, analyzing and processing the load signals, after which it transfers the power request to each distributed generation controller (DGC), so that the requested power is delivered as required [9], as shown in Fig. 3.

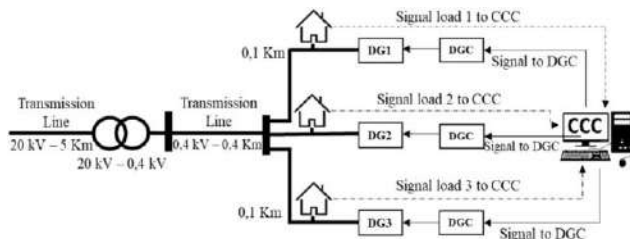


Fig. 3: Centralized Virtual Power Plant. Source [9]

Moreover, in this topology the control logic is the responsibility of the VPP and the planning of market and production are performed separately from the DER, this being an advantage given that the VPP can use the DERs to meet market demand [25]. The topology of this structure is shown in Fig. 4.

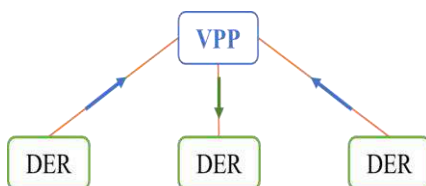


Fig. 4: VPP with Centralized Control [25]

G. Decentralized Virtual Power Plant

In this topology the active energy produced by the DER is controlled by the DGC which is controlled by a local controller (LC). Each DER has a dedicated LC that are connected to each other in the ring topology, thus ensuring a synchronized signal exchange, being treated as a single control center, as can be seen in Fig. 5.

For [25] this topology is named "VPP with fully distributed control", where each DER acts independently, reacting under its responsibility to the different states of the market or the energy system. This topology can be seen in Fig. 6.

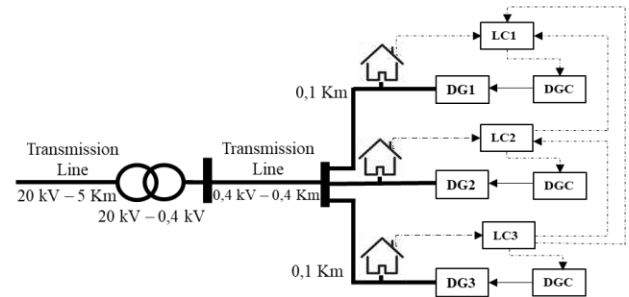


Fig. 5: Decentralized Virtual Power Plant [9].

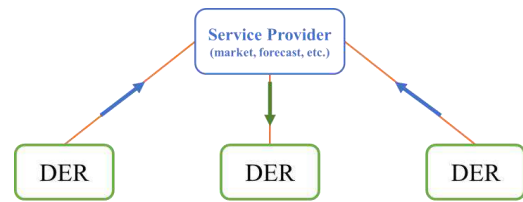


Fig. 6: VPP with fully distributed control [25]

H. Virtual Power Plant with Distributed Control

According to [25] there are levels of hierarchy, such that the coordination and supervision of DERs is performed by a local VPP (low level of control), while decisions are made by the VPP of high level of control. This simplifies the responsibilities and communication of each VPP [25]. The Fig. 7 shows the topology with distributed control.

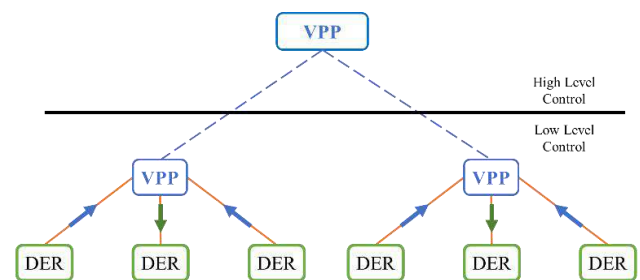


Fig. 7: VPP with distributed control [25]

V. TYPES OF VIRTUAL POWER PLANT

The different control topologies presented earlier, as well as the technologies employed in VPP, contribute to the VPP's responsibility to control the power supply and manage the flow between the VPP and the power grid in order to contribute to the quality of electric power. Therefore, according to [1] in order for VPP to fulfill these functions, it is necessary to have some tools, such as: Applications for control and monitoring; Intelligent metering and control of equipment installed in customers' homes; Software that guarantee the predictability of the generation of DERs and Communication Infrastructure

Thus, it is possible for VPP to perform its activities in order to guarantee the best results in connection with the system. To this end, VPP assumes two distinct roles: Technical Virtual Plant (TVPP) and Commercial Virtual Plant (CVPP). It is worth noting that both operate together and the role of each will be presented below.

I. Technical Virtual Power Plant (TVPP)

TVPP is composed of the generating units of the same geographic region, being responsible for the operation of these and the storage systems of each one, besides resolving technological restrictions and mainly the communication of the VPP with the distribution network [1], [26]. In the attributions of a TVPP is the control of the energy flow within the group of DERs, realization of continuous monitoring, management of financial issues, detection of faults and its location, besides the execution of auxiliary services to the system [1], [27]. To that end, CVPP is responsible for providing contractual information and controllable loads, this information must contain [1]: Maximum generation capacity and the commitment of each generating unit; Generation and consumption forecast; Physical location of generating units and loads; Location of storage system and capacity and Possible control strategy for controllable loads throughout the day in accordance with the contractual obligations between VPP and loads.

Based on this information TVPP ensures that the system will be operated safely and in an optimized way [1]. Furthermore, according to [1], TVPP will perform the following functions: (i) Manage the local system for the distribution system operator; (ii) Ensure balance, network management and execution of ancillary services; (iii) Allow the visibility of the DERs in the distribution network to the system operator, in order to allow the distributed generation to contribute to the demand of the distribution system; (iv) Observe the operation of the DER according to the information obtained with CVPP;

(v) Continuously monitor equipment condition; (vi) Asset management based on statistical data; (vii) Auto identification of system components; (viii) Determine missing places; (ix) Facilitate maintenance and (x) Optimize project portfolio and statistical analysis. The Fig. 8 shows in a summarized way the necessary inputs and outputs that characterize the activity of a TVPP.

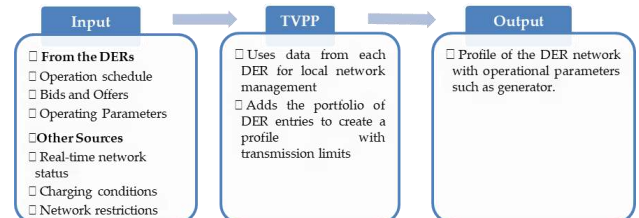


Fig. 8: Synthesis of inputs and outputs of a TVPP [2].

J. VPP Commercial (CVPP)

According to [26] CVPP is responsible for the VPP business in the energy market, managing the business portfolio and providing services to the system operator. The operator of a CVPP is usually a third party aggregator or a party responsible for maintaining the balance between the VPP and the market, for example, an electric utility. It is a representation of a set of DERs that can be used to participate in the energy market in the same way as a centrally generated plant, this mode of operation reduces to the associated DER the risks that would be exposed in a particular operation in the energy market, in addition to providing the benefits of resource diversity and increasing generation capacity through cooperation with other generating units [2].

CVPP optimizes the use of VPP in the energy market, generating bilateral contracts between DERs and other customers. These contracts are sent to TVPP where they are analyzed and considered in the planning and predictability of generation, once the unit will have another contractual generation [1].

CVPP allows small generating units to enter the electric power market, since these are not allowed when acting in a solitary way, since their production is not enough, and can have consequences in the face of non-guarantee of service to demand. The features of a CVPP are listed in [1], as follows: (i) Schedule production based on customer need forecast; (ii) Negotiate throughout the electricity market; (iii) Manage the business portfolio; (iv) Provide services to the system operator; (v) Send features and maintenance costs of DER; (vi) Forecast production and demand based on weather forecast and consumption profile; (vii) Elaborate proposals for DER

and sending to the energy market, (viii) Schedule generation and daily optimization and (ix) Sell energy from the DER in the energy market .

Still according to [1], to achieve the above objectives, CVPP interacts with the following entities: (i) DER: Its main function is to fill the gap between demand and production. The production requirement of the DER should be planned with anticipation this planning should be sent to TVPP for scheduling; (ii) Party Responsible for the Balance (PRB): It is an electric energy business entity whose purpose is to prepare its own energy consumption / production plan in such a way that it is used by TVPP and (iii) TVPP: Receives the information of the CVPP considering them during the optimization of the operation of the VPP and its interaction with the main network .

Unlike TVPPs, the CVPP can represent DERs from several different locations in systems that allow unrestricted access to the energy market, however in regions where energy resources are critical the CVPP will be restricted to include only DER from the same locality[2].

The possibility of the CVPP representing DERs from any part allows the generating units to choose which CVPP will represent it in the electricity market [2]. The Fig. 9 shows the synthesis of inputs and outputs of a CVPP.

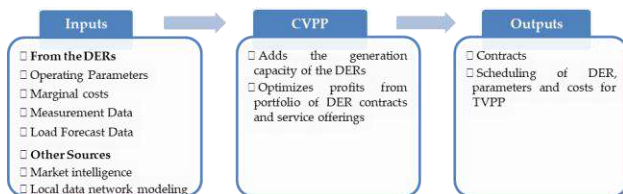


Fig. 9: Synthesis of inputs and outputs of a CVPP [2].

K. Advantages and Disadvantages of VPP

Although there are a limited number of VPP and research projects related to the subject so far, it is possible to find some references of advantages and disadvantages of implementing this topology (Table 5), which will be presented below, according to [9] e [25].

Table 5. Advantages and disadvantages of VPP [9] [25].

Advantages	Disadvantages
- Optimization of the units of distributed generation to provide services to the distribution network.	- Climate dependence of generation resources.
- Reduction of losses in transmission and distribution.	- Need for a robust cyber security system to control VPP.
- Decrease in the emission of	- Uncertainty of the dynamic response to the

greenhouse gases, since sustainable sources are used to generate energy by DER.

- Economic benefits to members of distributed generation units.
- Slows the need for the construction of new plants by concessionaires.
- Provides services such as network disturbance filtering and reactive power compensation.
- It allows concessionaires to provide customized energy delivery services to individual consumers while simultaneously optimizing the production and distribution of electricity at costs much lower than those practiced in the current system.
- Through the CVPP facilitates the access of the RSD to the electricity market.

L. Rules and regulations

In Brazil, the regulation that most closely approximates VPP is Normative Resolution n° 482/2012, which presents the shared generation, such as the characterization of the meeting of consumers within the same concession area or permission, through a consortium or cooperative, composed of individual or legal entity. However, it does not provide for the control of the generating units by a third party or the possibility of the sale of energy to the concessionaire. In Brazil the energy produced by GD is offset in the energy consumed by the property where GD is installed, this credit will remain available for the property for the period of 60 months.

VI CONCLUSION

This article reviews Virtual Power Plants (VPP). Its different definitions and possible questions generated to the reader are due to the fact that the concept is relatively new and, therefore, research about this is scarce. On the other hand, although the concept is new, it shows itself in line with the current needs of the evolution of the energy market and evolution of the increase in demand. The concept of CVPP facilitates and encourages

entrepreneurship and it is hoped that more people will enter the energy market through cooperatives or consortia. TVPP has the greatest benefit in controlling distributed units and the predictability of generation.

In Brazil, to date we do not have information about installed VPPs and few research works on the subject, therefore, this work helps future researchers to understand the concept and the main aspects regarding VPP.

ACKNOWLEDGEMENTS

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REFERENCES

- [1] M. M. Othman, A. Y. Abdelaziz, and Y. G. Hegazy, "A Review of Virtual power plant Definitions , Components , Framework and Optimization A Review of Virtual power plant Definitions , Components , Framework and Optimization," vol. 6, no. February 2016, 2015.
- [2] D. Pudjianto, D. Pudjianto, C. Ramsay, C. Ramsay, G. Strbac, and G. Strbac, "Virtual power plant and system integration of distributed energy resources," *Renew. Power Gener. IET*, vol. 1, no. 1, pp. 10–16, 2007.
- [3] P. Lombardi, M. Powalko, and K. Rudion, "Optimal operation of a virtual power plant," *IEEE Power Energy Soc. Gen. Meet.*, pp. 1–6, 2009.
- [4] P. Lombardi, "Multi Criteria Optimization of an Autonomous Virtual Power Plant with a High Degree of Renewable Energy Sources," *Proc. 17th PSCC*, 2011.
- [5] G. Koepfel, "Distributed Generation - Literature Review and Outline of the Swiss Situation," no. November, pp. 1–19, 2003.
- [6] M. Braun, "Virtual Power Plants in Real Applications Pilot Demonstrations in Spain and England as part of the European project FENIX," *Int. ETG-Kongress*, no. August, pp. 3–8, 2009.
- [7] J. M. Morales, A. J. Conejo, H. Madsen, and M. Zugno, *Integrating Renewables in Electricity Market - Operational Problems*. New York: Springer, 2014.
- [8] H. Saboori, M. Mohammadi, and R. Taghe, "Virtual power plant (VPP), definition, concept, components and types," *Asia-Pacific Power Energy Eng. Conf. APPEEC*, 2011.
- [9] T. K. V. Hernández, "Uma proposta de integração da geração distribuída, por meio das usinas virtuais, ao Sistema Elétrico do Estado de São Paulo," *Diss. em Energ. do Inst. Energ. e Ambient. da Univ. São Paulo – USP*, p. 152, 2015.
- [10] A. van der Welle, C. Kolokathis, J. Jansen, C. Madina, and A. Diaz, "FENIX a step towards the future of electricity networks. Assessment of costs and benefits of FENIX: Final Report," *Eur. Comm. Sixth Framew. Program. Res. Technol. Dev.*, p. 70, 2009.
- [11] N. E. Rosman, "Impact Analysis of a Virtual Power Plant," 2017.
- [12] M. Armstrong and A. Galli, "Impact of VPP on the Day-Ahead Market in France Accepted for publication in the *Journal of Energy Markets*," vol. 33, no. April, pp. 12–13, 2009.
- [13] C. Tranchita, "France Pilots Virtual Power Plant," no. April, 2016.
- [14] X. Wang et al., "Multi-Objective Virtual Power Plant Construction Model Based on Decision Area Division," *Appl. Sci.*, vol. 8, no. 9, p. 1484, 2018.
- [15] E. A. Setiawan, *Concept and Controllability of Virtual Power Plant*. 2007.
- [16] V. S. Bhadoria, N. Singh, and V. Shrivastava, "A Review on Distributed Generation Definitions and DG Impacts on Distribution System," *Int. Conf. Adv. Comput. Commun. Technol. (ICACCTM - 2013)*, no. November, 2013.
- [17] "Distributed Generation in Liberalised Electricity Markets," 2002.
- [18] L. I. Dulău, M. Abrudean, and D. Bică, "Distributed Generation Technologies and Optimization," *Procedia Technol.*, vol. 12, pp. 687–692, 2014.
- [19] M. Faisal, M. A. Hannan, P. J. Ker, A. Hussain, M. Mansur, and F. Blaabjerg, "Review of energy storage system technologies in microgrid applications: Issues and challenges," *IEEE Access*, vol. 3536, no. 1, 2018.
- [20] S. Koohi-Kamali, V. V. Tyagi, N. A. Rahim, N. L. Panwar, and H. Mokhlis, "Emergence of energy storage technologies as the solution for reliable operation of smart power systems: A review," *Renew. Sustain. Energy Rev.*, vol. 25, pp. 135–165, 2013.
- [21] P. Lombardi, T. Sokolnikova, Z. Styczynski, and N. Voropai, *Virtual power plant management considering energy storage systems*, vol. 8, no. PART 1. IFAC, 2012.
- [22] O. Starynets, "PG Thesis-Communication in microgrids and virtual power plants," no. June, 2016.
- [23] M. Kuzlu and M. Pipattanasomporn, "Assessment of communication technologies and network requirements for different smart grid applications," *2013 IEEE PES Innov. Smart Grid Technol. Conf. ISGT 2013*, 2013.
- [24] H. Bai, S. Miao, X. Ran, and C. Ye, "Optimal Dispatch Strategy of a Virtual Power Plant Containing Battery Switch Stations in a Unified Electricity Market," pp. 2268–2289, 2015.
- [25] L. I. Dulau, M. Abrudean, and D. Bica, "Distributed generation and virtual power plants," *2014 49th Int. Univ. Power Eng. Conf.*, no. December, pp. 1–5, 2014.
- [26] M. Thesis, S. Development, and T. Olejnczak, "Distributed Generation and Virtual Power Plants: Barriers and Solutions *Energy and Resources*," *Integr. Vlsi J.*, no. 0357022, 2011.
- [27] S. Ghavidel, L. Li, J. Aghaei, T. Yu, and J. Zhu, "A review on the virtual power plant: Components and operation systems," *2016 IEEE Int. Conf. Power Syst. Technol. POWERCON 2016*, pp. 1–6, 2016.

Identification of the Dynamic Model of a Distillation Column

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Abstract— This paper presents the results of the identification of the dynamic equations of a binary distillation column. Due to the many characteristics that involve multi-variable systems, we use a linear identifier to estimate the top and bottom concentrations of a generic column, considering as input the injected steam flow in the heat exchanger of the reboiler and the recycle rate. The use of linear models is justified, considering that, in practice, it works in very narrow bands around the setpoints. Within these ranges, the linear models are quite accurate. The set of input and output data, necessary to proceed with the identification of the system, was obtained based on a theoretical model of a generic binary distillation column. In practice, these data should be obtained directly from an industrial process. The details of the simulation, as well as the results of the identification process, are presented.

Keywords— Distillation column, System identification, Predictive control.

I. INTRODUCTION

Due to the great complexity in the equations that determine the behavior of the chemical industry processes, the use of physical laws in the modeling of these systems becomes impracticable in many cases. To solve this problem, a considerable computational effort is used to identify these systems based on input and output data of the processes. In this way, the systems identification techniques are necessary for the construction of these models (Aguirre, 2007).

The dynamic model identification can be performed in real time, or in batch mode. Large response times and parameters that vary slowly, usually appear in most industrial chemical processes. For this reason, offline identification becomes necessary even when the goal is the synthesis of adaptive or predictive controllers. The offline identification gives the designer the possibility to know and understand the dynamics of a given system, replicating its real behavior, through a set of experimental data.

In this work, the set of input and output data sets required to identify the system was obtained based on a theoretical model of a generic binary distillation column found in (Skogestad and Postlethwaite, 2007). In practice, these data should be obtained directly from the industrial process. The ident toolbox of the Matlab system was used

to identify the predictive model. The details of the simulation, as well as the results of the identification process, are presented in section 4 of this paper. Initially, a summary of the operating principles of binary distillation columns is presented.

II. DISTILLATION COLUMNS

Distillation is a unitary operation widely used in chemical industries to separate components. The separation of the phases from a liquid-liquid mixture is carried out by differences in the volatile compositions between the chemical components of the mixture. The component with the lowest boiling point, i.e., more volatile, is called distillate, the other component having a higher boiling point or less volatile is called a residue, or bottom product. When heat is supplied to the mixture, the more volatile substance will vaporize first. In order to carry out this process, a large amount of energy is required, which can involve about 30 to 40% of total energy resources in processes common to the chemical industry (Yang and Lee, 1997). Distillation columns require control systems capable of keeping the process stable and efficient. Thus, the identification techniques presented in this paper are intended to assist the design of such controllers.

Although current distillation plants present great efficiency in the separation process, regarding energy

efficiency, they have very low results. Precise and robust control of distillation columns would help increase the profitability of the plant by saving energy and improving the recovery of the final product.

2.1 Distillation Process

The binary distillation is a process used to separate only two products with different compositions. It consists in separating a mixture composed of two pure liquids, with different boiling points (different volatilities). By the time the blend is heated, the more volatile components are removed at the top of the column, and the less volatile components are removed by the lower part of the column, as shown in Figure 1. For example, a mixture of ethanol and water may be separated by distillation because ethanol is more volatile than water.

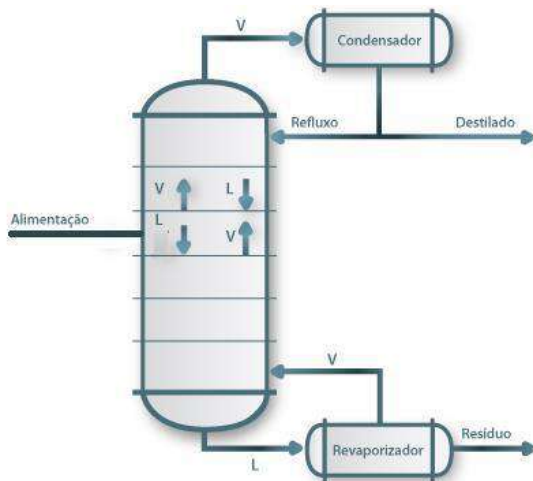


Fig.1: Schematic of a distillation column

The binary distillation column, shown in Figure 1, presents some advantages, such as simple operation, low initial investment when compared to other separation processes and is often considered a process with low operational risk. A disadvantage in the distillation process is the low energy efficiency and the need for thermal stability by the components at their boiling points.

2.2 Components of a distillation column

There are several components in a distillation column that are intended to make the transfer of thermal energy, such as:

- Vertical vessel where the liquid component is separated;

- Internal components of the column, such as trays used to increase component separation;
- Reamer to provide the vaporization required for the distillation process;
- Condenser to cool and condense the steam leaving the top of the column;
- Recycle drum, used to store the condensed steam from the top of the column, so that some part of the product can be returned to the distillation process to improving the concentration of the final product.

The diagram of a typical ethanol distillation system, consisting of three columns, in series, is shown in Figure 2.

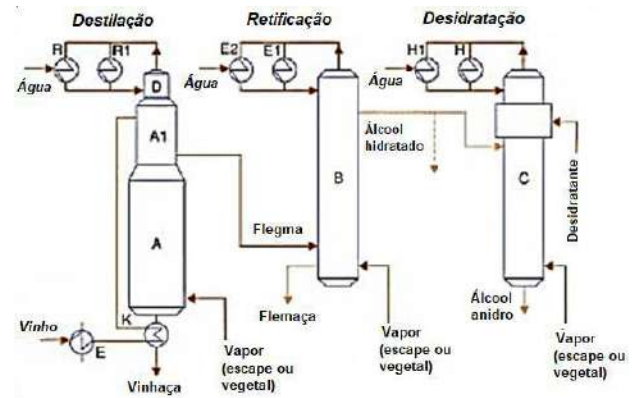


Fig.2: Diagram of a typical distillation column.

2.3 Working principle

From the control point of view, the binary distillation column (Fig. 3) is a multivariate system with the following control variables (SKOGESTAD, 1990):

- Reflux flow;
- Steam flow;
- Distillate flow rate;
- Flow of the bottom product;
- Condenser flow rate responsible for the removal of heat.

The five process variables are:

- Pressure at the base, intermediate or top;
- Bottom level;

- Reflux tank level;
- Composition of the bottom product;
- Composition of the distillate product.

There are several possibilities that can be used as control strategies for distillation columns. The distillation columns are, in practice, controlled hierarchically, first the level and pressure controllers are designed. Control strategies with multiple inputs and multiple outputs can be applied in such a way to regulate pressure and levels in the bottom and in the top tanks. This maintains the stock of material that ensures safe operation of the column and prevents the occurrence of drainage and flooding (Luyben, 1992). Another detail is that the dynamics of the composition and level control loops are decoupled, and the quality controls of the bottom and top products are simplified by reducing the column model to a system with only 2 inputs and two outputs (Skogestad et al., 1990; Luyben, 1992). This simplified model is used in the identification process presented below.

III. IDENTIFICATION OF THE LINEAR PREDICTIVE MODEL OF A DISTILLATION COLUMN

For the development of this work, the data obtained from the simulation of a binary column presented in (Skogestad and Postlethwaite, 2007) were used. This model consists of a first order transfer function (1), having as input the recycle rate (L) and the vapor flow (V) of the referent. The outputs are the concentrations of the top product (yD) and the bottom product (yB), (Figure 3).

$$G(s) = \frac{1}{75s + 1} \begin{pmatrix} 87.8 & -86.4 \\ 108.2 & -109.6 \end{pmatrix} \quad (1)$$

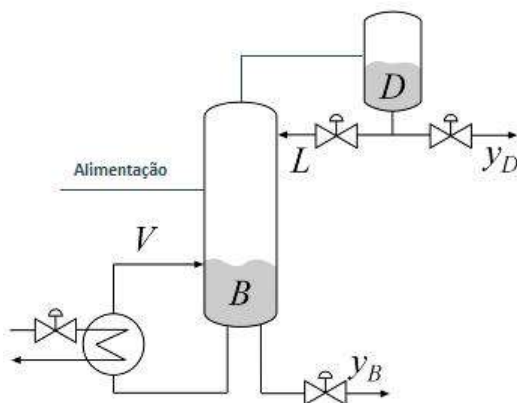


Fig.3: Distillation column.

In this work, the transfer function presented in (1) was used only to generate data, through simulations that

allowed the identification of the predictive model. In an actual distillation column, the data should be obtained directly from the process.

This process exhibits strong coupling and large variations in steady-state gains for some combinations of L and V (Skogestad and Postlethwaite, 2007).

IV. DEVELOPMENT AND RESULTS OF THE IDENTIFICATION OF A DISTILLATION COLUMN

The dynamic equation of the distillation column can be generated with predictive characteristics, that is, based on the current input data obtained directly from the process, we infer the values that will occur at the exit, in the next sampling instants. This is the main tool for the implementation of predictive controllers. Thus, the results obtained in this work should be used in further works of predictive control for distillation columns.

To identify the dynamic model of the distillation column, data corresponding to the following quantities were generated:

Input: - steam flow at the inlet of the boiler (range 0 to 1200 kg / h); - opening of the recycle valve (range from 0 to 100%).

Output: - top product concentration (range 0 to 100%); - concentration of the background product (range 0 to 100%).

In order to obtain the necessary data for the identification process, the transfer function presented in (1) was simulated using the Simulink tool of the Matlab system, using random values for the steam flow (V) and for the recycle rate (L).

Two sets of data were generated with a sampling interval of 1 second, the first set corresponding to the training data and the second one to the validation data.

Among the various options available, the order status model 8 presented in (2) showed the best results:

$$\begin{cases} \dot{x} = Ax + Bf \\ y = Cx \end{cases} \quad (2)$$

In equation (2) we have:

\dot{x} : derived from x with respect to time (dx / dt)

x: state vector, $x \in \mathbb{R}^8$

A: order status matrix 8x8

B: 8x2 order entry matrix

C: output matrix of order 2x8.

f: input vector ($f \in \mathbb{R}^2$), corresponding to the steam flow of the and the percentage of recycle.

In the identification process, matrices A, B and C were estimated and are presented in equations 3, 4 and 5, respectively.

y: output vector ($y \in \mathbb{R}^2$), corresponding to the concentrations of top and bottom.

$$A = \begin{bmatrix} 3.751 & 155.6 & 6.221 & 11.44 & 12.98 & -84.74 & -14.71 & -41.65 \\ 100.3 & 4161 & 164.3 & 306.4 & 345.9 & -2264 & -391.9 & -1113 \\ 140.6 & 5827 & 226.6 & 430.4 & 482.5 & -3167 & -545.9 & -1557 \\ -322 & -13350 & -527.8 & -983 & -1110 & 7265 & 1259 & 3571 \\ -81.54 & -3376 & -126.9 & -252.3 & -277.4 & 1828 & 311 & 898.7 \\ 101.1 & 4196 & 167.8 & 307.7 & 349.8 & -2286 & -397.5 & -1124 \\ 101.3 & 4207 & 171.6 & 306.7 & 352.7 & -2297 & -402.4 & -1129 \\ 41.54 & 1719 & 62.68 & 129.3 & 140.3 & -928.4 & -156.3 & -456.8 \end{bmatrix} \quad (3)$$

$$B = \begin{bmatrix} 1.046 & -1.048 \\ 28 & -28.04 \\ 39.25 & -39.29 \\ -89.82 & 89.96 \\ -22.76 & 22.78 \\ 28.22 & -28.26 \\ 28.25 & -28.3 \\ 11.61 & -11.61 \end{bmatrix} \quad (4)$$

$$C = \begin{bmatrix} 380 & -7.26 & 0.8163 & -13.1 & -6.333 & 1.156 & -1.055 & -2.748 \\ 480.2 & -9.737 & 3.471 & -14.39 & -12.21 & 3.906 & -1.593 & -10.11 \end{bmatrix} \quad (5)$$

To prove the effectiveness of the model obtained, the validation data were applied in the simulation and in the prediction tests. They are shown in the following section.

4.1. Simulation Testing

In this test, the values of the state variables obtained by simulation at the current instant are used to calculate the outputs at the later time. Figure 9 shows the actual and the simulated values in the same plot. It is possible to prove the effectiveness of the model, both visually, since it is difficult to visualize the two functions, as numerically, since a hit rate of 93.64% was obtained, as shown in Figure 10.

This type of model is, in general, used for simulation and analysis of the process, with a view to the design of controllers.

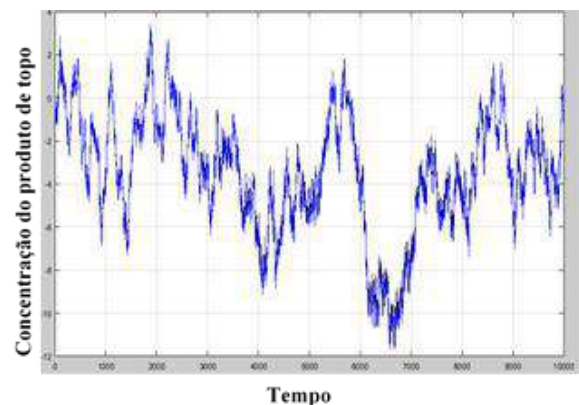


Fig.9: Comparison of the simulation result with the data used for model validation.

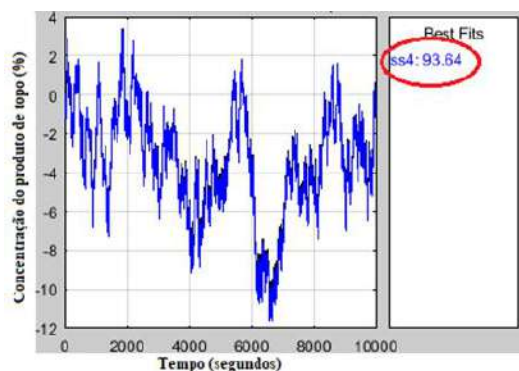


Fig.10: Hit rate in the simulation with the data used for model validation.

PREDICTION TEST

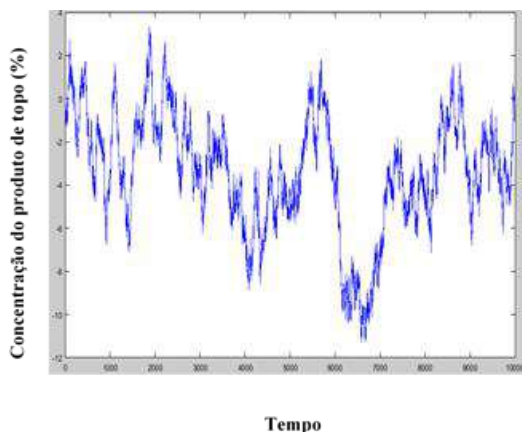


Fig.11: Comparison of the forecast result with the data used for model validation.

In this test, the measured quantities are used at the current instant, in the process itself, to infer the values that will occur at the exit in the next instants (Figure 11). In this way, there is no accumulation of error, obtaining a higher rate of correctness. In the case of this work, we obtained 99.45%, as can be observed in Figure 12.

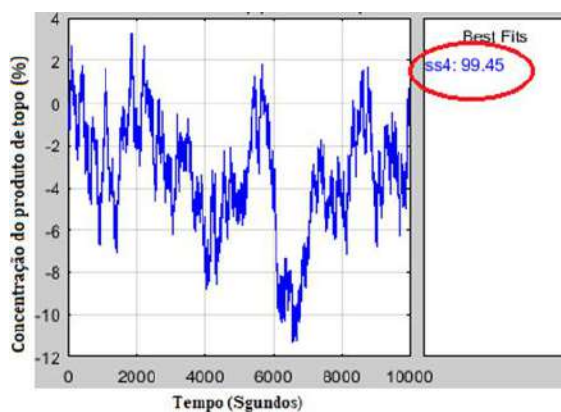


Fig.12: Forecast accuracy rate with the data used for model validation.

This type of model is used in strategies of predictive and adaptive control.

V. CONCLUSION

The results obtained in this work indicate the feasibility of the use of linear models for the identification of the dynamic equation of distillation columns. Mainly, in the case of the prediction model, a very satisfactory result was obtained with a hit rate of 99.45%. Although the data used in this work for the estimation of the dynamic equations were obtained by simulation, it is expected that the use of actual plant data will also produce satisfactory results, which would enable its application in predictive or adaptive control strategies.

REFERENCES

- [1] AGUIRRE, L. A. **Introdução à identificação de sistemas: técnicas lineares e não-lineares aplicadas a sistemas reais**. UFMG, 2007. ISBN 9788570415844. Disponível em: <<https://books.google.com.br/books?id=h8u-AQAACAAJ>>.
- [2] LUNDSTRÖM, P.; SKOGESTAD, S. Opportunities and difficulties with 5×5 distillation control. **Journal of Process Control**, v. 5, n. 4, p. 249-261, 1995/08/01/ 1995. ISSN 0959-1524. Disponível em: <<http://www.sciencedirect.com/science/article/pii/095915249500017K>>.
- [3] LUYBEN, W. L. **Diagonal controller tuning**: Van Nostrand Reinhold: New York 1992.
- [4] SKOGESTAD, S.; LUNDSTRÖM, P.; JACOBSEN, E. W. Selecting the best distillation control configuration. **AIChE Journal**, v. 36, n. 5, p. 753-764, 1990. ISSN 1547-5905.
- [5] SKOGESTAD, S.; POSTLETHWAITE, I. **Multivariable feedback control: analysis and design**. Wiley New York, 2007.
- [6] YANG, D. R.; LEE, K. S. Monitoring of a distillation column using modified extended Kalman filter and a reduced order model. **Computers & Chemical Engineering**, v. 21, p. S565-S570, 1997/05/20/ 1997. ISSN 0098-1354. Disponível em: <<http://www.sciencedirect.com/science/article/pii/S009813549787562X>>.

Genetic Divergence in Corn Genotypes in the South of the State of Pará

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Abstract—The genetic variability allows selection of superior genotypes and makes it possible to increase the frequency of favorable genes through appropriate selection methods that provide genetic material's retrieval adapted to environmental conditions prevalent in the different producing regions. Thus, this work was performed with the goal of studying the genetic divergence of populations of open pollination of corn in the South of Par  State. To this end, two tests were made of corn genotypes competition, being the first to top P (100 kg ha⁻¹ of P) and the second for low P (50 kg ha⁻¹ of P). The study of genetic divergence was performed using together with the data from the two trials. The experimental design used in each trial was randomized with ten treatments (open-pollinated maize genotypes) and three repetitions. The characteristics studied were: plant Height, Ear height, the diameter of the Spike, Spike length, grain in the row numbers and productivity. In the study of genetic divergence was employed the Tocher optimization method. The importance of characters, was the Foundation of Singh. Three medium-sized groups were formed, which were in the same genotypes 08 groups, and two other genotypes (AG 1051 and AL BANDEIRANTE.), were in different groups. The characters presented more collaboration for the genetic divergence were productivity, plant height and ear height.

Keywords—*Zea mays*, Phosphate fertilization, Genetic improvement, Genetic variability

I. INTRODUCTION

The importance of corn, in addition to the nutritional aspect, is linked to the social aspect, because large producers do not have widespread technology and/or large tracts of land, and yet still depend on for a living. According to IBGE, this fact is evidenced by a large number of producers who use corn still on the property, about 59% of the establishments that produce this cereal [12, 14].

In the State of Par , the corn productivity is low (3320 crop -17/18 and 2962 crop 18/19) when compared with the productivity of other regions such as the southern region (5530 –crop 17/18 and crop 18/19-6658), Southeast (5385-crop 17/18 and crop18/19 5537) and Midwest (5354- crop 17/18 and crop 18/19 6000) [9]. Several factors are responsible for the low productivity of this culture in the North and, among these, include high temperatures, the low technological level used by local farmers and a shortage of genetic material adapted to the conditions local soil and weather [2, 3, 5].

A good fertility and fertilization of soils are

very important elements to the composition of an efficient production system, which can provide essential nutrients for corn, considering the actual need according to your phenology phase. For both, there is a need for an appropriate program of fertilization that consider an efficient diagnosis of soil fertility, meeting your nutritional requirement in order to facilitate the management, improve the absorption and accumulation of nutrients in the soil [7] [2]

Among the primary nutrients, phosphorus (P) is the least required by crops, in quantitative term, but plays important role in the growth of the root system of maize [19] [15]. However, it is very used in fertilization of crops in Brazil [1]. The lack of nutrients in the soil, where the deployment of culture, can cause disabilities and loss of production [1] [20].

Experiments involving genetic divergence are crucial to the understanding of genetic variety in germplasm banks, making possible the monitoring and recognition of likely duplicates, besides transfer criteria for selection of parents that, if they do, provide better

heterotic effect, adding the chances of obtaining genotypes more promising in future generations [4] [10].

Researchers have sought the use of analysis to quantify the genetic divergence between genotypes varied species, where maize stands out. In Brazilian literature, there are many works that address the study of divergence [13] [16] which aims to identify possible parents for future breeding programs. However, studies of this nature are rare in the South of Pará.

Based on the foregoing objective with the present study, study the tensions resulting from unclear between maize genotypes grown in southern Pará.

II. MATERIALS AND METHODS

Two tests were conducted in the municipality of Santa Maria das Barreiras-PA (Aw-type climate according to Köppen (1948) [18], with an average temperature of 26.5° C and average annual rainfall of 1968 mm), under conditions of high phosphorus (100 kg ha⁻¹ of P₂O₅) and another under low phosphorus (50 kg ha⁻¹ of P₂O₅), in planting. Sowing was made on 23 December 2017.

In Figure 1, the average values of precipitation (mm) and temperature (°C), of the last 30 years [6].

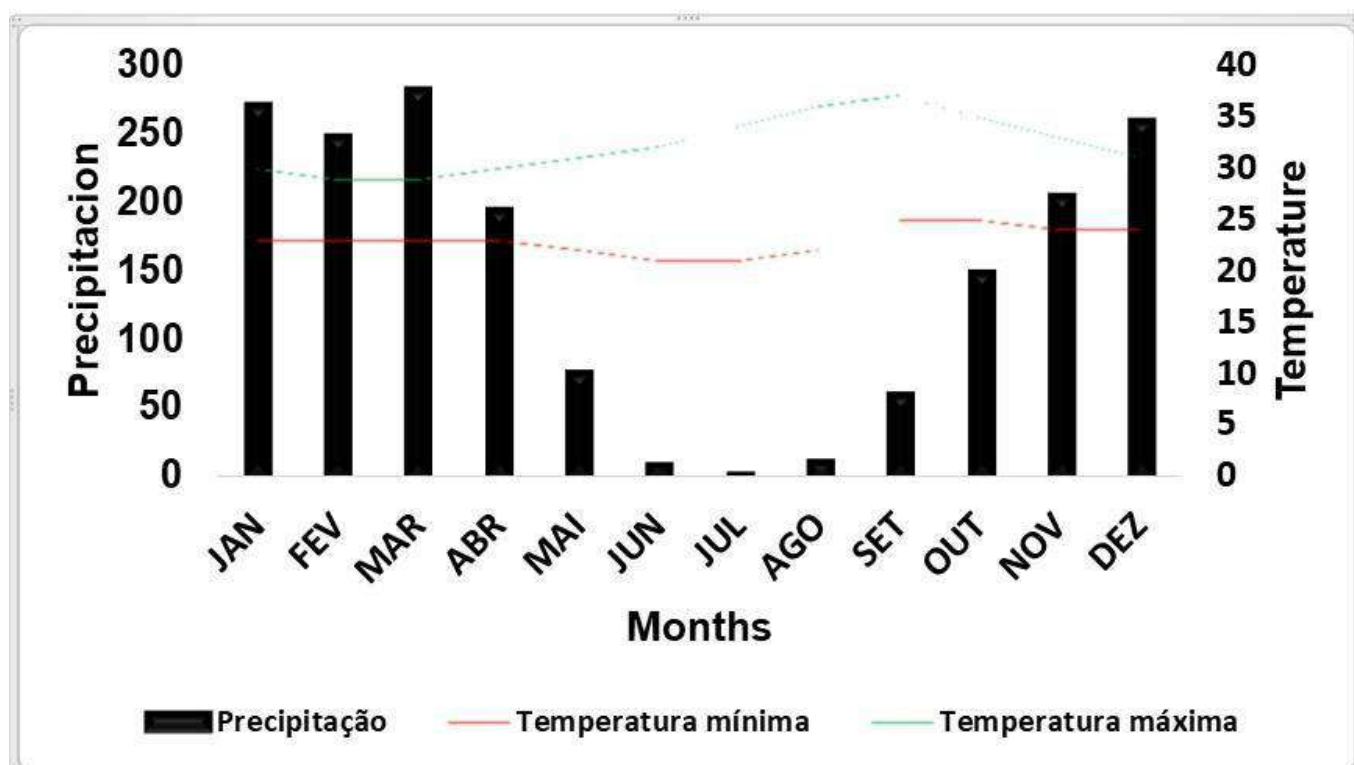


Fig. 1: Monthly values of air temperature (°C) and precipitation (mm) total rain in the last 30 years regarding the climatic conditions in the municipality of Santa Mariadas Barreiras, State of Pará. Source: Climate (2018).

The treatments were composed of ten genotypes of open pollination (AG 8088, BRS 3046, PR27D28, CATIVERDE, 2B655PW, ANHEMBI BR 206, AG 1051, AL BANDEIRANTE and ORION), separated into random blocks with three replications. The experimental plot was formed by four rows of five meters away, 0.90 m considering between the lines.

In soil, preparation procedures were plowing, harrowing and sulcamento, with the application of fertilizers manually held in grooves for later deployment of culture. Phosphate fertilization levels, defined in pre-planting, consists of 100 and 50 kg ha⁻¹ of Super simple

for High P and low P, respectively.

The fertilization in coverage of N and K was held at the stage V4 and V8 (four and eight leaves completely open, respectively), being the nitrogen fertilization performed with urea (43% N), at a dose of 150 kg ha⁻¹, and potassium fertilization with potassium chloride (60% K) on dose of 90 kg ha⁻¹.

The seeding was done manually and the plant management, such as the control of pests, diseases, and invasive plants, was held as the need for culture [17].

The stage R6 (physiological maturity) the harvest of the ears using two lines in each row,

disregarding -0.50 m surround themselves.

The following variables were analyzed from each plant: The plant height measurements were calculated from the base, low to the ground, until the insertion of flag leaf, using a metric measuring tape. Insert Tenon measures were calculated from the base of the plant until the insertion point using a metric measuring tape. The diameter and length of the cob were determined with the aid of a digital pachymeter, the number of grains was determined in each row by the count of the amount of grain on each ear, in order to get an estimate. Productivity was obtained through the collection of spikes and calculating the average weight of their grain. From the average weight of grains, multiplying the result by the number of plants, obtaining the average productivity for the moisture of 13% in grain.

For the study of genetic divergence was the Mahalanobis generalized distance (D^2).

For the Organization of similar groups was employed the method of optimizing Tocher (RAO, 1952).

It was possible to calculate the relative contribution of the characters used for the genetic divergence and the dissimilarity between the observed total offspring using the criteria suggested by Singh (1981) [26].

The data were analyzed through the statistical program Genes, 2007 version [11].

III. RESULTS AND DISCUSSION

The genetic dissimilarity measures assumed by Mahalanobis distance (table 1), highlighted the existence of genetic variation (4.4 to 197.3) among the genotypes analyzed.

Table.1: Dissimilarity among corn genotypes in relation to features as the Mahalanobis generalized distance (D^2_{ii}).

Genotypes	BRS 3046	PR27D2 8	ANHEM BI	CATIVE RDE	2B655P W	BR 206	AG 1051	AL BANDEIRANTE	ORION
AG 8088	17,5	11,7	14,6	34,4	20,5	13,8	34,4	69,0	12,1
BRS 3046		27,5	6,9	26,2	24,0	43,6	19,8	134,2	24,5
PR27D28			29,5	46,0	36,1	5,5	69,5	55,4	9,7
ANHEM BI				34,8	23,1	37,9	16,8	135,3	23,9
CATIVERDE					4,4	46,6	66,1	104,0	20,0
E									
2B655PW						32,0	54,1	89,6	12,3
BR 206							86,3	35,6	9,4
AG 1051								197,3	65,2
AL									
BANDEIRA NTE									62,3

The shortest distance was obtained between the genotypes CATIVERDE and 2B655PW ($D^2 = 4.4$) followed by the PR27D28 genotypes and BR 206 ($D^2 = 5.5$) and BRS 3046 and ANHEM BI ($D^2 = 6.9$). On the other hand, the pair AG 1051 and AL BANDEIRANTE presented the biggest difference ($D^2 = 197.3$), followed by the combinations of ANHEM BI and AL BANDEIRANTE ($D^2 = 135.3$) accompanied by BRS 3046 and AL BANDEIRANTE ($D^2 = 134.2$). The smaller the distance between the genotypes, the greater the genetic equality between them, reducing the possibility of success to obtain hybrids with a high degree

of heterosis [21] [24] [22].

The study of the improvement of Tocher, based on Mahalanobis distance matrix, separated the ten genotypes in three distinct groups (table 2). The method of search Tocher distinguishes similar pair in the differentiation, i.e. the pair to submit a lower estimate of distance and have relatively similar characteristics among themselves [22]. It is observed that in Group I were eight genotypes AG 8088, BRS 3046, PR27D28, CATIVERDE, 2B655PW, ANHEM BI BR 206 and ORION genetically alike. Groups II and III were represented by only one genotype each AG 1051 and AL BANDEIRANTE, respectively.

Table 2: Grouping as Tocher method based on the generalized distance of Mahalanobis to 10 (ten) maize genotypes.

Groups	Genotypes
I	AG 8088, BRS 3046, PR27D28, ANHEMBI, CATIVERDE, 2B655PW, BR 206 e ORION
II	AG 1051
III	AL BANDEIRANTE

The main point of the study is to obtain and use only the best genetic characters to produce future parents, which bring strains resistant to pests and diseases, with higher quality and increased production[25].

The relative contribution (%) (Table 3) showed that the plant height, Spike height and productivity were the ones that contributed to the genetic diversity among the genotypes compared and studies.

Table 3: Relative contribution of genetic divergence (in %) in the study of variance of features valued at corn genotypes.

Variable	Value (%)
Plant height	11,62
Height of the Spike	55,69
COB diameter	4,24
COB length	1,42
Number of Grains in the row	4,62
Productivity	22,40

The great interest in assessing the relative importance of the characters lies in the possibility of disclaiming features that contribute little to the breakdown of the rated material, reducing in this way, time, labor, and costs spent on experimentation [21].

Therefore, the number of grains per row, COB diameter and length of the cob can be discarded, since it showed a lower contribution to the divergence.

Coimbra et al. (2010) [8] and Santos et al. (2017) [23] evaluating different genotypes of maize, also observed low relative contribution of the features number of grains per row, COB diameter and length of the spigot on genetic diversity.

IV. CONCLUSION

Among the genotypes, AG 1051 and AL BANDEIRANTE, ANHEMBI and AL BANDEIRANTE and BRS 3046 and AL BANDEIRANTE are the most divergent, enabling the attainment of superior genotypes of the farmer's interest and more sustainable production.

Tocher method was effective in the separation of the groups.

The productivity features, plant height and ear

height were the ones that contributed to the study of genetic divergence.

REFERENCES

- [1] BARROS IB. Atributos físicos de Latossolo amarelo distrófico, sob diferentes fontes e doses de fósforo; (2018).
- [2] BORBA MDEA. Respostas fisiológicas da cultura do milho à diferentes manejos de adubação; (2018).
- [3] CANCELLIER LL, AFFÉRRI FS, CARVALHO, V E, DOTTO MA, et al. (2011). Eficiência no uso de nitrogênio e correlação fenotípica em populações tropicais de milho no Tocantins. Revista Ciência Agronômica. 42(1):139–148.
- [4] FILHO CARGNELUTTI, A RIBEIRO, D N, JOST E. (2009). Número necessário de experimentos para a análise de agrupamento de cultivares de feijão. Ciência Rural. 39(2):371–378.
- [5] CARVALHO HWL, SOUZA EM. Ciclos de seleção de progênies de meios-irmãos do milho BR 5011 Sertanejo. Pesquisa Agropecuária Brasileira; (2007).
- [6] Santa CLIMATEC. Maria das Barreiras. Disponível em: <<https://pt.climate-data.org/america-do-sul/brazil/para/santa-maria-das-barreiras-42788>>. Acesso em: 3 de novembro de; (2018).
- [7] COELHO AM. Nutrição e adubação. Embrapa Milho e Sorgo-Capítulo em livro técnico-científico; (2007).
- [8] COIMBRA RR, MIRANDA GV, CRUZ CD, MELO DE, V A, et al. (2010). Caracterização e divergência genética de populações de milho resgatadas do Sudeste de Minas Gerais. Revista Ciência Agronômica. 41(1):159–166.
- [9] B CONA; (2019). Companhia Nacional de Abastecimento. Acompanhamento da Safra Brasileira de Grãos, v.
- [10] CRUZ CD, FERREIRA FM, PESSONI LA. Biometria aplicada ao estudo da diversidade genética; (2011). 1 ed. Visconde do Rio Branco: Suprema.
- [11] CRUZ CD; (2007). Programa Genes: Aplicativo computacional em genética e estatística. Viçosa: UFV.
- [12] CRUZ CD, CARNEIRO PCS; (2006). Modelos biométricos aplicados ao melhoramento genético. Viçosa: UFV.
- [13] DIAS MAR, MELO AV, SANTOS VM, NUNES HV. Divergência genética entre progênies de milho na região centro-sul do estado do Tocantins. Revista Engenharia na Agricultura; (2018).
- [14] DUARTE JDEOD, MATTOSO MJ, GARCIA JCIS; (2019). Disponível em:

- <http://www.agencia.cnptia.embrapa.br/gestor/milho/arvore/CONTAG01_8_168200511157.html>. Acesso em. vol. 7.
- [15] MORAES C. Azospirillum brasilense E UM ISOLADO SOLUBILIZADOR; (2016).
- [16] SODRÉ LF. (2017). Divergência genética em milho para baixo e alto nitrogênio visando produção de óleo e proteína. Pesquisa Agropecuária Pernambucana. 22.
- [17] FANCELLI AL, DOURADO-NETO D; (2000). Produção de milho. Guaíba: Agropecuária.
- [18] KÖPPEN W. (1948). Climatología: con un estudio de los climas de la tierra.
- [19] MALAVOLTA E. Manual de nutrição mineral de plantas. São Paulo; (2006).
- [20] NOVAIS RF, ALVAREZ VVH, BARROS NF, FONTES RLF, CANTARUTTI RB, et al.; (2007). Fertilidade do solo. Viçosa: Sociedade.
- [21] ROTILI EA, CANCELLIER LL, DOTTO MA, PELUZIO JM, CARVALHO EV. (2012). Divergência genética em genótipos de milho, no estado do Tocantins. Revista Ciência Agrônômica, Fortaleza. 43:516–521.
- [22] SANTOS WF, AFFÉRI FS, PELUZIO JM. Eficiência ao uso do nitrogênio e biodiversidade em genótipos de milho para teor de óleo. Enciclopédia Biosfera; (2015).
- [23] SANTOS WF, MACIEL LC, SODRÉ LF, SILVA RM, AFFÉRI FS, et al. (2017). Diversidade genética em genótipos de milho para baixo nível tecnológico em Gurupi. TO Tecnologia & Ciência Agropecuária, João Pessoa. 11:2–21.
- [24] SANTOS WF, PELUZIO JM, AFFÉRI FS, SODRÉ LF, SANTOS DS, et al.. Variabilidade genética e eficiência de uso do nitrogênio em genótipos de milho para teor de óleo. Revista Ciência Agrárias; (2014).
- [25] SILVA KCL, SILVA KP, CARVALHO EV, ROTILI EA, AFFÉRI FS, et al.. Divergência genética de genótipos de milho com e sem adubação; (2015).
- [26] SINGH D. (1981). The relative importance of characters affecting genetic divergence. The Indian Journal of Genetics e Plant. Breeding. 41:237–245.

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Data Collection and Prediction of Urban Transport Flow using Neural Networks

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Abstract—Smart cities can use artificial neural networks to provide more accurate information about public transportation schedules, and thus help the population plan their day to day activities. In this context, this paper describes the essential steps for the acquisition and processing of data, and the creation of a neural network model capable of predicting possible delays or advances on bus lines in the city of Curitiba, Paraná. The neural network considers traffic data, climate, time and history of a public transport line. The article details all phases of collection and treatment, as well as how information is inserted into the network and what are the obtained results.

Keywords—Neural networks, transport prediction, smart cities.

I. INTRODUCTION

Collective public transportation is of great importance to Brazilian cities. These transit systems provide invaluable access and locomotion to some of the country's poorest citizens. Furthermore, collective public transportation vehicles help to reduce traffic congestion, mitigate emissions from individual automobiles and contribute to an overall strategy to promote cleaner and environmentally-friendly cities.

The urban public transport plays an important role in the current configuration of urban displacement as a means of transport that provides the interconnection between the various regions of the cities. It is an alternative to the reduction of serious problems found in cities such as: congestion, traffic accidents and environmental impacts [1].

Forecasting public transport delays can be an optimized tool that drivers and passengers could use to plan their daily tasks. This prediction can be obtained by analyzing data directly or indirectly linked to the line punctuality situation. Data collection is an important aspect of urban computing and is a determining factor in building smart cities [2].

This set of information could be used to create an artificial neural network that analyzes all this data and tries to find a possible connection between them, so that it creates an algorithm to predict situations of delay or advance, becoming a tool to help professionals in the area of data analysis and even to the user of the bus network.

In the scenario of the bus lines of public transport, one of the known issues is the compliance with the established schedules. Because it is a problem that in many cases is caused by factors that can not be controlled, it is not always possible to prevent it from happening. Predict these delays allows interested parties to have this information in advance and can decide how to work around the situation [3].

With population growth also increase the challenges for government, business and academia [4]. The analysis of data to create resources for intelligent cities has been the subject of several studies in both the academic and business environments. This technique of collecting and processing data can be of great value to companies and users who could benefit from a great amount of information, planning and improving their activities, but also to the government that could benefit from the improvement in the service provided. Research shows that the greatest cause of dissatisfaction among the Brazilian population with public transportation are the problems with capillarity and frequency, slowness and frequent delays, which, according to the research [5], cause the population to use less public transportation.

According to [6], congestion concerns all individuals. Brazilian metropolitan areas live a nightmare difficult to measure, which are urban congestion. The feeling of wasted time in front of a huge congestion is worrying, and there are few people who know how to live with this reality naturally. In recent years, millions of people have lost money and time because of congestion [7] and there is a considerable increase in the price of car trips during congestion [8, 9].

Knowing this reality this article proposes a solution of public utility so that the population knows of the expected delays of a bus line. The solution brings advantages such as reduction of the issues involved, and can benefit users of transport, service provider companies and government entities.

This article is organized as follows. Section II discusses related work. Section III describes the data collection considered in this paper, examines the data model and how they may or may not directly influence the final result. Section IV describes the experiments performed and how the data obtained was added to the neural network and which tool was used for this, also shows the results obtained and the network responses. Section V concludes the paper and presents future work.

II. RELATED WORK

The attempt to predict possible delays of collective public transport vehicles has already been considered in other works. Some of these studies involve computational intelligence, but the vast majority use only historical data and some other technique. On the other hand, some studies have more similar characteristics with this work and also use weather and traffic data.

In the work of Maciel [3], the performance of regression algorithms in historical data for the forecast of the start and end time of day trips is evaluated. The main idea was to evaluate the performance of regression algorithms and with them it was verified that, for both the start and end time of the trip, the median of the errors was approximately 28 and -167 seconds respectively. The work shows that the quality of the forecasts also changes over the course of the week, where the worst results were obtained on Monday and the best on Wednesday and Thursday. The same behavior of the days of the week was verified in the hours of the day, where the start and end times of the usual Brazilian work schedule obtained the most inconsistent results. They also considered some climate data and their influences.

In the work of Moraes Filho [10], a project called CittaMobi is presented, which is a set of solutions that aims to make public transport information available to bus users. The application provides real-time predictions of the arrival of the bus, the locations of the closest points, together with the lines that pass through them, and some details related to each bus, for example, if the bus is adapted to the holders of special needs, or not.

On the other hand, the work of Serafim [11] consists of an experiment carried out in the area of public transportation, with data obtained by an observer and collected with direct observation of the arrival of the bus. In the study,

data were collected for 23 days. To evaluate the punctuality of the bus, it was admitted that the process of generating a random sequence of delays, anticipations and certain hours on a given day must be influenced by what happened in the previous days and can therefore be described by a Markov chain. Besides the estimation, some simulated samples of these chains were also used in the work. However, it was verified that for samples of size up to 50 days, there is not sufficient information to detect a dependency structure, even if the practicality of the use of modeling of a variable through the chain was evidenced.

The idea of improving the information offered to public transport users, based on information provided by other individuals, was worked by Lucio [12]. In the work, collective intelligence is used, which is described as a form of distributed intelligence, constantly improved by its users and coordinated in real time, resulting in the creation of knowledge through collaboration. The work shows how the resources provided by mobility in conjunction with collective intelligence can be used to create Intelligent Transport Systems (ITS). In this scenario, the data required for the creation of these intelligent systems are provided by the users of the public transportation through their mobile devices, providing the construction of a large collection of information of the transportation system through the contribution of the users.

III. EXPERIMENTAL ANALYSIS

For the prediction times of the path of a line of public transport in Curitiba, it is necessary to collect data about this line and additional data that may influence its path. These lines have routes that meander through the city, being of great use by the passengers, passing through terminals and streets that have a great flow of people and vehicles. The additional data is based on climate information and traffic incidents in a generic way and without any specific category, which, for both, has a great impact on the flow of vehicles. The acquisition process is to: identify lines, collect real-time basis and time schedules of the line and of each vehicle; identify and collect weather data from the region of Curitiba, targeted in temperature, humidity, wind speed and description of the weather; and, finally, collect traffic data based on line locations.

After the data is collected, the stored information is analyzed. Before submitting them for processing with the neural network, it is necessary to identify and translate the information. Some of the data collected is based on natural language. It is not necessary to carry out a more advanced classification based on Natural Language

Processing (NLP), since the terms used are very limited. This classification is necessary only for the weather and traffic data, to simplify data entry to a model of the neural network.

3.1 Data Collection

To perform the prediction, historical data are needed, especially those that may have a connection with public transport bus delays. These data were collected in several ways and in several formats: weather data, history of delays of the chosen line, data of traffic and traffic flow in the region transited by the bus at the time of collection, among others.

3.1.1 Climatic Data Collection

Authors report that the adverse weather conditions cause significant changes in travel decisions [13]. A relationship between weather conditions and traffic flow is addressed in [14], showing a relationship between weather conditions and traffic speed, as well as a link between these conditions and the number of accidents. This set generates a change in traffic flow, shown in Fig. 1.

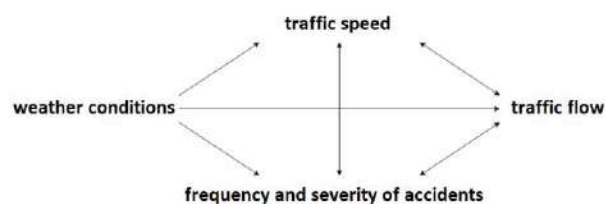


Fig. 1: The relationship between weather, road safety, traffic speed and traffic flow.

Also in [14], it is shown that on rainy days the number of passengers in buses decreases and the number of cars on the streets increases. The authors point out that not only the number of passengers is influenced by the weather but also the time it takes to complete the route to its destination and the time waiting for the public transport vehicle. In conclusion, precipitation, cloudiness, wind speed, high temperatures and hail can alter the intensity of traffic and underline the need to incorporate meteorological conditions into research directly or indirectly linked to traffic.

Climatic conditions, along with brightness and visibility, and their link to traffic flow and the number of accidents are shown in studies in Orange County, California [15]. In this work, some data about the possible influence of the weather conditions are shown in tables, which are checked on some links between the traffic flow speed and weather conditions.

With this in mind, some data on climatic conditions in the region of circulation of the bus are necessary. Climate information was found in the form of web service. The web service chosen for use in this research was the HG Weather - Weather Forecasting API [16] which is a project designed to disseminate information for free. In this web service, we can obtain data using: the city code (WOEID), Geo IP, Geolocation or by the name of the city.

The mode chosen was using the WOEID code which, according to [17], is an acronym for Where On Earth Identifier, which marks the location of cities and identifies each with a specific code. For the city of Curitiba the WOEID is 455822, and this way of obtaining data was chosen because it does not require an access key. The data provided by this web service are: temperature, date and time of data update (refresh occurs approximately every 30 minutes), a code of the current climate condition, a broad description of the current climate, a reduced description of the current climate, current weather information for 'day' or 'night', city name with the code entered, air humidity, wind speed and sunrise and sunset times, and the general forecast for the next few days.

3.1.2 Data Collection from the Bus Line

Bus timeliness data on different days and times should be collected for forecasting. This collection should be periodic and occur long enough so that results can be observed. The authors suggest two years of data collected daily and every 3 minutes, ensuring that a different data will be acquired from the last one, so that the database is sufficient for use and extraction of useful data. It is suggested that one year of data could already bring satisfactory results. This is possible since the Curitiba City Hall provides documents and government information for web services through an action called Open Data Portal [18]. This data is available in open format for use and unrestricted editing of its users, thus being in the public domain and free use, and are intended to produce new information and digital applications for society.

The service is in its first version, and it provides databases of the various organs of the Municipal Government of Curitiba. These bases are available through the web site to download, or via web services with direct access. The information available for download is updated every month, and can be accessed without the need for a term signature or personal identification, with or without commercial purpose. The information coming from the web service is released through the delivery of a document containing the user's login and password by

URBS S/A (Company of Urbanization of Curitiba), and has static data, which do not require frequent updating, or dynamic, which are updated every 2 minutes, depending on the type of service. For example, data from the city's main points of interest are static and do not require updating, since location data and information on the delay situation or not on a particular line change at all times, and therefore have frequent updates.

To request access to the data of a certain line it is necessary to inform the code of the line, which are 3 characters and can be found in the service itself. When entering the code line, the following data are available: prefix of the vehicle, which is the specific code of each vehicle in the network, the time of the update, latitude and longitude data in floating point, the line prefix, which is the code entered when requesting data, information if are adapted for wheelchair users (1 for yes, 0 for no), type of the bus, the timetable that the vehicle is performing (normal or Sundays and holidays), a situation of the vehicle timetable (late, early, on time) and the counter of cycles without updating vehicle information, since the information is updated every two minutes. At each cycle of two minutes without update this counter is increased by 1 (updated information has code 1). The line chosen for the work was 022 - Inter 2.

3.1.3 Traffic Data Collection

Congestion in the city makes everyone involved slow down and increase the time spent in traffic. Considering this, traffic data and traffic flow in the region trafficked by the bus are also important and should be considered.

One way to collect this data is the Bing Transit [19] web service that also responds with a JSON file with some information about accidents or impediments in a rectangular area formed by two latitudes and two longitudes that represent the four sides of that area. The following syntax is used to specify this area: a south latitude, a west longitude, a north latitude, and an east longitude. The information provided after specifying the region is: time and type of accident or impediment (closed street, construction on the road, collisions of vehicles, fallen tree). For use in this work only the number of events in the area was used.

The Web Scraping that was used in this research is a way of requesting data, collecting and analyzing it to extract desired information by writing a simple code to perform the task [20]. In [21] it is said that web services are the standard, in fact, for data collection. However, there are scenarios where data is not available through web services and the use of Web Scraping becomes necessary.

Web Scraping can be used on real-time map and traffic sites, since there are many of them that show the current flow of traffic in a particular location, which could be used at the time of collection. An example is the Google Maps tool [22] that reports the time between two points in real time and whether the traffic flow is flowing slowly or quickly. For use in this work it was decided to use only the current time between the arrival and departure points of the Inter 2 line, that is, when the time was higher than the average the flow is slow and when the arrival time is lower the flow it is faster and therefore faster the bus ride.

The current time data between the starting point of the line and the endpoint was initially acquired using the Requests library which is a Python HTTP library that aims to make HTTP requests simpler and more human friendly according to documentation in [23]. One of the uses of the library is the return of the HTML code of the chosen web page and within that code the information of the time is in the form of text and that piece of text that is the number of minutes between the points is extracted. This value can then be used to describe the flow of current traffic in the region.

3.1.4 Additional Data Collection

A data of great importance to the network is the day of the week in which the collection was performed. The day of the week is important because on the Friday before a holiday, for example, there is a very different flow of traffic from common Tuesdays. First, the day-of-the-week data can be obtained in Python (a programming language chosen for being one of the options for using Keras that will be used for the neural network and for having support for all the services used, making only one needed) using the Calendar library. To get the day of the week we should move the date to a function called "weekday" and it returns the day of the week from the informed date. Information about special dates or holidays were obtained using a web service called "Rest-API with Holidays from all cities of Brazil" [24] and in it is informed the IBGE (Brazilian Institute of Geography and Statistics) code of the chosen city and has as return the national, state and municipal holidays of the city in question. The code of Curitiba is 4106902. When collecting the data a simple comparison of the current day with the holidays is done to verify three situations and the answer is transformed into 3 bits: the first bit for holiday eve, another for holiday day, and the last for a day after the holiday, being bit 1 for true answer and bit 0 for false.

Other data could also influence, such as the occurrence of large events in the region, and even others of the human conviviality itself. Event information could be collected in digital newspapers in the region or on news websites,

also through Web Scraping or RSS, but have not been used so far.

3.2 Pre-processing of data

Some data such as the day of the week, the climate description and the bus situation, are in text format and should be changed to number, since the neural network model can use numbers as input data to become more optimized. In the first case the following transformation was made, Sunday for number 1, Monday for number 2, Tuesday for number 3 and so on. For the climate description the following criterion was adopted, all possible answers were listed and for each one assigned a number, for example "Cloudy weather" was transformed into 1 and "Sunny" in number 4. For the situation of the bus the same technique was used, however using 3 numbers each being 0 or 1 depending on the situation, delayed became 100, early 010 and on schedule became 001.

An example of collection is shown in Table 1 and in it the following data are present: day of the week, which in the example is the number 6 which is equivalent to a Friday, day and month of collection which in this case is a day 24 of August, the hour and minute of collection, in case 12:11, the temperature in the city at the time of collection, 29 degrees celsius in the example, also the description of the current climate, in case 4 that is "sunny", the humidity of the air, in the collection equal to 40%, condition slug 1 that is equal to "clear day", then a code of the climate condition in question (code generated by the web service itself), the number of events collected in the region, holiday and, lastly, the current time between the start and end of the line, at that moment was 29 minutes.

Data	Value
Weekday	6
Day	24
Month	8
Hour	12
Minute	11
Temp	29
Description	4
Humidity	40
Condition Slug	1

Condition Code	32
Incidents	0
Holiday eve	0
Holiday	0
After Holiday	0
Time	29

Table 1: A collection of input data held on August 24 at noon and eleven minutes.

The output data is three, the first one being a bit representing delay or not, the second is ahead or not, and the last is on time or not. In no case two of these bits can have the value 1, since the bus can not be delayed and advanced at the same time, for example. In Table 2 we see an example of output data, where the condition is 100, that is, delay at the time of collection.

Output Data	Value
Late	1
Early	0
On Time	0

Table 2: A collection of output data held on August 24 at noon and eleven minutes.

When performing the first tests it was observed that it would be better to change the qualitative data also for the binary form, since the neural network works with weights and sizes when it comes to numbers. The quantitative data were kept in their decimal form. Leaving in the qualitative form might seem to the neural network that Monday is less than Saturday for example, or that description 4 is larger than description 1, which is not a truth, the idea that should be passed to network is another, it should be something like "it's Monday", yes or no. Then the following change was made, changing the day-of-week fields, description, quick description and condition code to a binary form that would be, yes or no for each possible case, 1 or 0, respectively. For the day of the week, for example, the number of the day has become 7 values, each one being equivalent to one day of the week. Monday, for example, was 1000000, and Tuesday was 0100000. This formatting was used for all cases cited.

A data acquisition was done for 3 months, only to verify the operation and then continue the data collection, resulting in that time in 3000 data obtained. After this collection the data were used to create the neural network.

IV. EXPERIMENTS EXECUTION

In order to implement the objective of predicting delays, it is necessary to predict events. Prediction is to make affirmations about something that will happen, usually based on information from the past and current state. Neural networks can be used for prediction, having advantages such as automatic learning of dependencies, requiring only measured data without any need to add more information. Moreover, the network can be trained from historical data, not having to be represented by an explicitly given model.

4.1 Neural Network

According to [25], Neural Networks, or Artificial Neural Networks, find applications in very diverse fields. By virtue of their ability to learn from input data, with or without a teacher, and by representing a technology rooted in various disciplines (such as neuroscience, math, statistics, physics, computer science, and engineering). Some examples of these fields are modeling, time series analysis, pattern recognition, signal processing, and control. As stated in [26], artificial neural networks can be considered as a methodology to solve problems characteristic of artificial intelligence.

Neural networks are massive and parallel systems, composed of simple processing units that compute certain mathematical functions [27]. Using a set of examples presented, the networks are able to generalize the assimilated knowledge to a set of unknown data. They also have the ability to extract non-explicit characteristics from a set of information provided to them as examples [28].

4.2 Experiment setup

Keras is described in its documentation [29] as an open source neural network library written in Python. It is able to work with tools like Google TensorFlow [30]. Designed to enable rapid experimentation of deep neural networks, it focuses on being easy to use, modular and extensible. It is an open source library for numerical computation and machine learning [31], and used as the neural network of this work.

To make use of the tools a code in Python language was developed, with data input and output in a Comma-separated values (CSV) file that allows the creation of tables with data separated by commas. The number of training times was defined, a hit and error quantity classifier was created and an interface showing the response of the system to an input (late, early or on time).

The best result was obtained without changing the optimizer and with 10 training periods. The model uses

only two layers of training being the first with the input data and the second with the output with 15 and 3 neurons each.

The final configurations used were: two layers (at first the settings were "normal" in the kernel initializer option, "relu" in the activation option, the second the same option in the kernel initializer and "softmax" in the activation option). To compile the model the settings were: "categorical_crossentropy" for the loss configuration and "sgd" optimizer. In the model training settings were: 10 epochs, 100 batch_size and 0 verbose.

4.3 Results obtained

The network, after the training, obtained a response with 84.59% accuracy in the validation data and 92% in the training data so far, that is, the network used some of the data collected to train and the rest to verify, where 90% was for training. When comparing the results obtained with the results collected in 84.59% of the cases, the network obtained a correct answer (the highest percentage was the correct answer).

These data are presented as a chance to occur, for example, a forecast for June 20 with rain at 12:00 was made and the following results were obtained: 23.74% chances that the bus is late, 9.81% chance of can be early and 66.43% chances that the bus will be on time. So the final response from the network is that the bus will probably be on time on June 20 at noon. The result that can be verified in the day and time in question, if the climatic conditions are predicted correctly.

In view of the results presented here, the network presents a reasonable response considering some field tests with positive results and possibly when performing a larger data collection the network may present an even better response.

V. CONCLUSION

The population satisfaction with public services is from great importance for improving the quality of life, facilitating day-to-day living, and raising the level of satisfaction with the government. The area of public transportation has a huge problem with delays and requires methods that obtain good accuracy in their predictions. Considering this need, this work proposed an approach for the city of Curitiba, focused on the collection of information that may be directly related to delays. The proposed approach is based on the collection of data from various moments and sources in a way that it makes possible the use of neural networks for prediction.

The results achieved have been satisfactory at first and from them a more in-depth research can be done, and then the data can be distributed to users as a way to improve the level of satisfaction with public transportation.

The paper presented here exposed a methodology for collecting data linked to possible changes in the flow of buses in the city of Curitiba and how these data can be used to predict these variations in advance using neural networks, notify users and whom they care about. The next objective is to develop a platform in which users would be able to identify the bus that they will use and what time they want to arrive and the platform could notify the user of the ideal time to board the bus or show the user a table with the schedules for departure and arrival of the chosen bus.

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REFERENCES

- [1] Rodrigues, M. A. e Sorratini, J. A. (2008). A qualidade no transportecoletivo urbano. Panorama nacional da pesquisa em transportes, 1081-1092.
- [2] Sá, D., & Rezende, D. A. (2019). Economia Da Inovação No Contexto Da Cidade Digital Estratégica: Caso Do Município De Curitiba. *Perspectivas em Gestão & Conhecimento*, 9(1), 62-81.
- [3] Maciel, M. D. A. (2016). Previsão de horários dos ônibus do sistema de transporte público coletivo de Campina Grande.
- [4] Gama, K., Alvaro, A., & Peixoto, E. (2012). Em direção a um modelo de maturidade tecnológica para cidades inteligentes. *Simpósio Brasileiro de Sistemas de Informação*, VIII.
- [5] Fonseca, R., Marques, M. C. & Velloso E. (2015). Retratos da Sociedade Brasileira - Mobilidade urbana. ISSN 2317-7012. Ano 5. Número 27.
- [6] Resende, P. D. T. V., & Sousa, P. R. D. (2009). Mobilidade urbana nas grandes cidades brasileiras: um estudo sobre impactos do congestionamento. SIMPOI-SIMPÓSIO DE ADMINISTRAÇÃO DA PRODUÇÃO, LOGÍSTICA E OPERAÇÕES INTERNACIONAIS, FGV.
- [7] Bertini, R. L. (2006). You are the traffic jam: an examination of congestion measures. *Transportation Research Board*, Washington DC.
- [8] Rufolo, A. M., & Bianco, M. J. (1998). The impact of congestion pricing and parking taxes on spatial competition.
- [9] Van der Ploeg, F., & Poelhekke, S. (2008). Globalization and the rise of mega-cities in the developing world. *Cambridge Journal of Regions, Economy and Society*, 1(3), 477-501.
- [10] Moraes Filho, H. D. (2017). Aplicação para monitoramento de frota de ônibus de transporte coletivo no Distrito Federal.
- [11] Serafim, M., Oliveira, M., Esteves, D., & Duarte-Neto, P. (2014). Modelo de previsão de partida de ônibus utilizando cadeias de Markov de alcance variável (pp. 624-628). *Revista da Estatística da Universidade Federal de Ouro Preto*, 3(3).
- [12] Lucio, D. R. (2011). Um aplicativo para dispositivos móveis voltado para usuários de transporte público (Bachelor's thesis, Universidade Tecnológica Federal do Paraná).
- [13] Khattak, A. J., & De Palma, A. (1997). The impact of adverse weather conditions on the propensity to change travel decisions: a survey of Brussels commuters. *Transportation Research Part A: Policy and Practice*, 31(3), 181-203.
- [14] Cools, M., Moons, E., & Wets, G. (2010). Assessing the impact of weather on traffic intensity. *Weather, Climate, and Society*, 2(1), 60-68.
- [15] Golob, T. F., & Recker, W. W. (2003). Relationships among urban freeway accidents, traffic flow, weather, and lighting conditions. *Journal of transportation engineering*, 129(4), 342-353.
- [16] Meteorological Data HG Weather - Weather forecast API [HG Brasil 2018 | HG Weather 2009 – 2018 [Online]. Retrieved from <https://hgbrasil.com/>
- [17] Tardy, C., Moccozet, L., & Falquet, G. (2016, April). A simple tags categorization framework using spatial coverage to discover geospatial semantics. In *Proceedings of the 25th International Conference Companion on World Wide Web* (pp. 657-660). *International World Wide Web Conferences Steering Committee*.
- [18] Open Data Portal - Curitiba City Hall. [Online]. Retrieved from www.curitiba.pr.gov.br/dadosabertos/
- [19] Microsoft, Inc. Bing Maps APIs. [Online]. Retrieved from <https://msdn.microsoft.com/pt-br/library/dd877180.aspx>
- [20] Mitchell, R. (2018). *Web Scraping with Python: Collecting More Data from the Modern Web*. " O'Reilly Media, Inc."
- [21] Glez-Peña, D., Lourenço, A., López-Fernández, H., Reboiro-Jato, M., & Fdez-Riverola, F. (2013). Web scraping technologies in an API world. *Briefings in bioinformatics*, 15(5), 788-797.
- [22] Google Maps - Navigation and public transport. [Online]. Retrieved from www.google.com.br/maps/
- [23] Reitz K. Requests, Python HTTP for Humans. (2018). [Online]. Retrieved from <http://docs.python-requests.org/en/master/user/quickstart/>
- [24] API Rest-full web service - Holidays from all Brazilian cities. [Online]. Retrieved from <http://www.calendario.com.br/>
- [25] Haykin, S. (2007). *Redes neurais: princípios e prática*. Bookman Editora.

- [26] Barreto, J. M. (2002). Introdução às redes neurais artificiais. V Escola Regional de Informática. Sociedade Brasileira de Computação, Regional Sul, Santa Maria, Florianópolis, Maringá, 5-10.
- [27] Braga, A. D. P., Carvalho, A. P. L. F. & Ludemir, T. B. (1998). Fundamentos de redes neurais artificiais. Rio de Janeiro: 11a Escola de Computação.
- [28] Kovács, Z. L. (2002). Redes neurais artificiais. Editora Livraria da Física.
- [29] Keras: The Python Deep Learning library. [Online]. Retrieved from <https://keras.io/>
- [30] Google TensorFlow [Online]. Retrieved from <https://www.tensorflow.org/>
- [31] Araújo, F. H., Carneiro, A. C., Silva, R. R., MEDEIROS, F. N., & USHIZIMA, D. M. (2017). Redes Neurais Convolucionais com Tensorflow: Teoria e Prática. SOCIEDADE BRASILEIRA DE COMPUTAÇÃO. III Escola Regional de Informática do Piauí. Livro Anais-Artigos e Minicursos, 1, 382-406.

Repowering of Small Hydropower Plants: A bibliometric study in the Scopus Database

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Abstract— This study aimed to carry out a survey on the repowering of Small Hidropower Plants - SHP, which is related to energy innovation and sustainable development. To obtain the data was used to bibliometric study technique using the database Scopus Elsevier, through the CAPES portal, considering data from the last two decades. It was possible to verify the increase in quantity of articles related to the subject over the years and analyze the main authors, journals with higher frequency of publication on the subject, the main institutions, countries and areas of knowledge related to the work, and a survey the most relevant articles in each of the selected themes. For best performance, data were presented graphically.

Keywords— Small Hydropower Plants (SHP); repowering; Energy Innovation; Sustainable development; Bibliometric study.

I. INTRODUCTION

On the horizon of the Ten-Year Expansion Plan (PDE) 2026 (EPE, 2017), to meet add electricity demand is necessary to maintain a distributed energy sources, focusing on renewable sources (Hydropower, wind, solar and biomass), taking into account the social and environmental assumptions. The projection is that the renewable sources are responsible for 90% of the electricity generation in 2026.

Together, the hydropower plants, small hydropower - PCHs generating plants and hydropower stations are responsible for 64% of all electricity generated, and

corresponding to 3.62% PCHs and CGHs (ANEEL, 2019).

According to the National Energy Plan - PNE - 2030 (EPE, 2007), most of the hydraulic potential to be tapped is in the North, bringing a number of challenges of economic, social and environmental character. It also calls for planning and participation of various sectors: government, academia, ONGs, local communities, etc.

The Hydro Power still has lower costs compared to other renewable energy sources, in addition to providing energy security, complementarity with other renewable,

operating flexibility and maintaining a low carbon energy matrix (EPE, 2017).

According to ABRAGEL (2017), the power plants can meet the current difficulties of UHEs, reducing: transmission and distribution losses and delays in licensing / construction.

In an attempt to reduce environmental impacts from new hydropower projects and still meet the growing demand for electricity, there are some alternatives through technological innovations, among them we can highlight the repowering process.

According to Oliveira (2012), repowering is the application of a hydro development interventions and may be civil structures in hydraulic circuits or devices that comprise the generation process (turbine, generator, etc.) to improve efficiency and power.

Repowering is a procedure that is to somehow increase the power generation of an existing hydro plant.

According to Oliveira (2012), all hydro dams, be UHE, PCH or CGH, to a greater or lesser extent, can pass through repowering process, either undersized or lag.

Based on the large energy gain that can be provided through the repowering of Small Hydropower, through the application of new innovative or correcting design deficiencies technologies, this study aims to examine how this method has been used around the world.

II. METHODOLOGY

For this work, a bibliometrical study will be applied. According to Fonseca (1986), bibliometry is a quantitative analysis technique and statistical measurement of the rates of production and dissemination of specific knowledge.

It will apply the model proposed by Costa (2010), in which data about the main authors will be raised, countries, years, institutions, journals and areas of knowledge of publications related to the topic of repowering Small Hydropower Plants.

The original sample corresponds to articles indexed in the database Scopus Elsevier, with access through the Journals Portal of *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES*, in June 2019.

The survey was conducted by applying temporal filter, between the years 2000 and 2019, and document type, in this case, articles. Table 1 shows the selected keywords for search and the amount of found articles.

Table 1 – Keywords

Theme	Key Words	Articles Found
Small Hydropower Plant	" <i>Small Hidropower Plant</i> "	199

Repowering	" <i>Repowering</i> "	215
Energy innovation	" <i>Energy Innovation</i> "	9692
Sustainable development	" <i>Sustainable Development</i> "	77705

Source: Prepared by the author.

III. RESULTS AND DISCUSSION

By Elsevier Scopus database, the articles related to each of the keywords were analyzed.

The sample presented contains data related to the number of publications per year, authors, journals, institutions, countries and areas of knowledge more often published in addition to the most relevant articles within the range of the last two decades (2000-2019).

3.1 Small Hidropower Plant - SHP

For this session, the terms used for the research were "*Small Hidropower Plant*". Applying the filter to articles, the search returned 199 results.

3.1.1 Publications per year

In Figure 1 you can graphically view the data relating to publications per year, from 2000 to 2019 range.

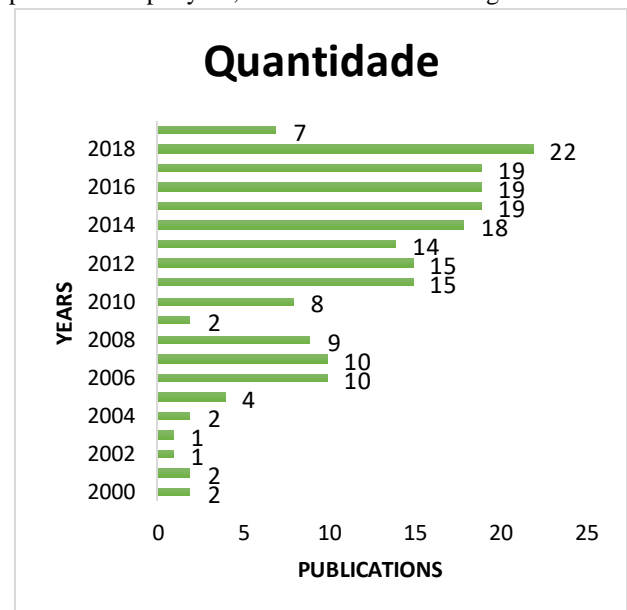


Fig.1: Frequency Plot publications per year in the period 2000-2019.

Source: Adapted from Scopus (2019).

You can check that the year 2009 showed a very low number of publications in this area, only two, then the volume is growing again. In 2019 found 7 articles to date this research.

3.1.2 Authors

The authors further reported on small hydro power stations, in the range 2000 - 2019 are shown in Figure 2.

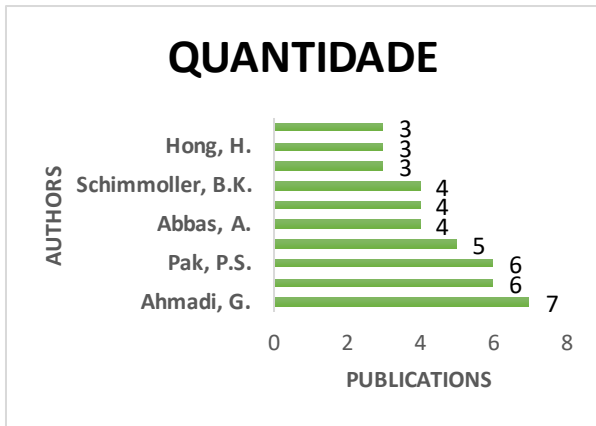


Fig.2: Graph authors with higher frequency of publication.

Source: Adapted from Scopus (2019).

3.1.3 Journals

The data about which journals had higher publications on the subject are shown graphically in Figure 3.

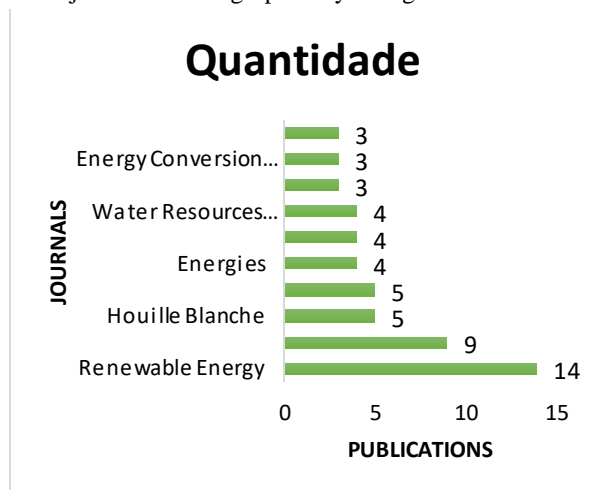


Fig.3: graph with periodic higher frequency of publication.

Source: Adapted from Scopus (2019).

3.1.4 Membership

The affiliates who contributed to the publications are illustrated graphically in Figure 4.

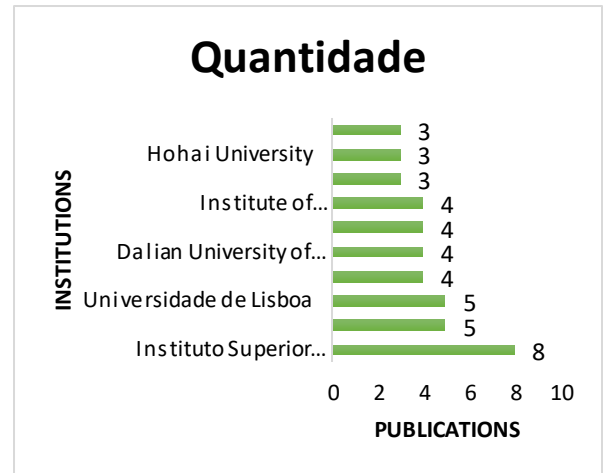


Fig.4: Graph institutions with higher frequency of publication.

Source: Adapted from Scopus (2019).

As noted, Brazil has highlighted this issue due to the work of the Federal University of Rio de Janeiro - UFRJ.

3.1.5 Countries

In Figure 5, below, are graphically represented the countries that contributed to publications in this period.

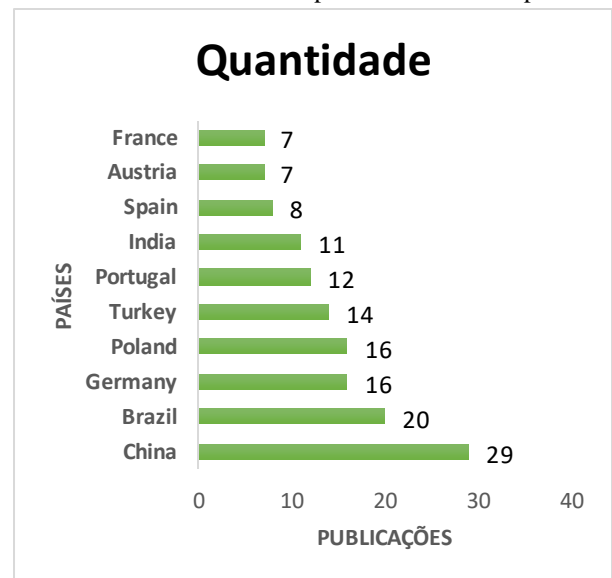


Fig.5: Graph of the countries with higher frequency of publication.

Source: Adapted from Scopus (2019).

Twenty publications, Brazil ranks second in the ranking, demonstrating that, in addition to having a predominant energy sources of hydropower, contributes to the development of the sector.

3.1.6 Knowledge Area

The data in Figure 6, illustrated below, graphically demonstrate knowledge areas with the highest frequency of publication on the subject.

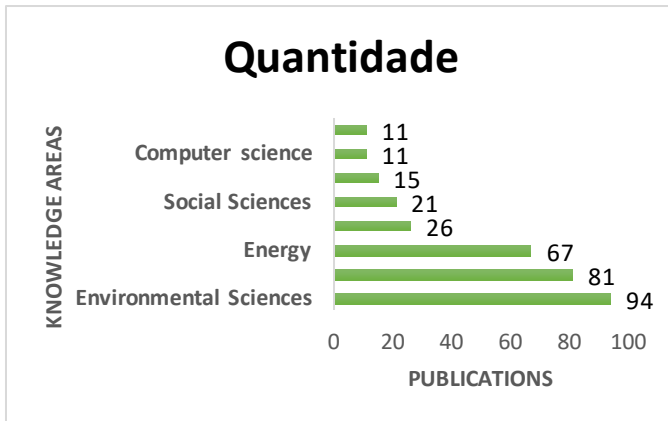


Fig.6: Chart of the areas of knowledge with higher frequency of publication

Source: Adapted from Scopus (2019).

3.1.7 Analysis of Articles

Table 2 presents the articles more relevantly, i.e. those with the largest number of citations, according to the database.

Table 2: Most relevant articles - Small Hydropower Plants.

TITLE	AUTHORS	YEAR	CITATIONS
<i>Investment timing and optimal capacity choice for small hydropower projects.</i>	BØCKMAN, T. et al.	2008	93
<i>Energy Production in Water Distribution Networks: A PAT Design Strategy.</i>	CARRAVETTA, A. et al.	2012	92
<i>Ecological consequences of hydropower development in Central America: Impacts of small dams and water diversion on neotropical stream fish assemblages.</i>	ANDERSON, E.P. et al.	2006	80
<i>The role of hydro power and contribution of small hydropower plants for sustainable development in Turkey.</i>	DURSUN, B., GOKCOL, C.	2011	66
<i>Optimal sizing of a run-of-river small hydropower plant.</i>	ANAGNOSTOPOULOS, J.S., PAPANTONIS, D.E.	2007	56

Source: Adapted from Scopus (2019).

3.2. Repowering

For this section, the term used for the research was "Repowering". Applying the filter to articles, the search returned 215 results.

3.2.1 Publications per year

In Figure 7, you can graphically display the number of publications per year about repowering, in the 2000 to 2019 range.

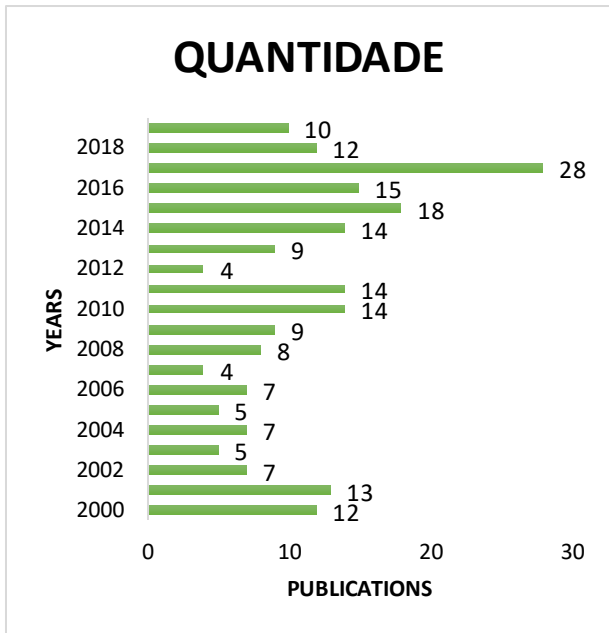


Fig.7: Frequency Plot of publications per year in the period 2000-2019.

Source: Adapted from Scopus (2019).

Note that there was a peak of publications in the year 2017 (28 posts) and a fall in 2018 (12 publications). In 2019 the trend is for this number to further increase, considering that to date the research have been published 10 articles.

3.2.2 Authors

The authors most frequently published on Small Hydro Power in the range 2000 - 2019 are shown in Figure 8.

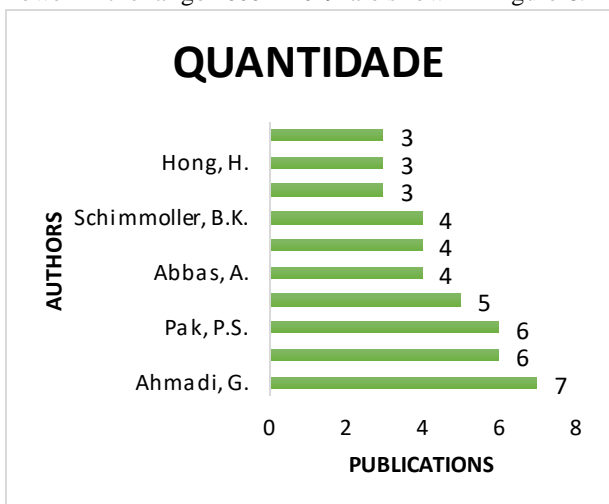


Fig.8: authors graph with higher frequency of publication.

Source: Adapted from Scopus (2019).

3.2.3 Journals

The data about which newspapers had the highest frequency of publication on the subject are illustrated graphically in Figure 9.

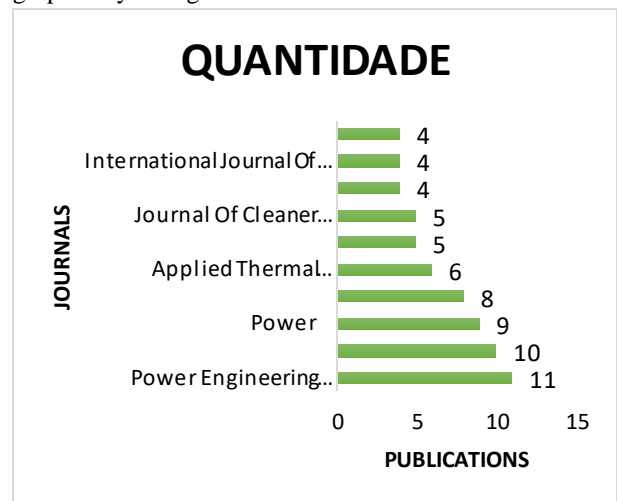


Fig.9: Graph periodic higher frequency of publication.

Source: Adapted from Scopus (2019).

3.2.4 Membership

The affiliates who contributed to the publications are illustrated graphically in Figure 10.

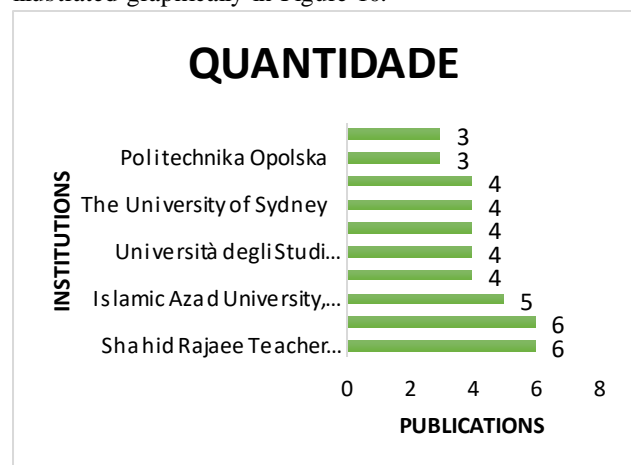


Fig.10: Graph institutions with higher frequency of publication.

Source: Adapted from Scopus (2019).

3.2.5 Countries

In Figure 11, below, are graphically represented the countries that contributed to publications in this period.

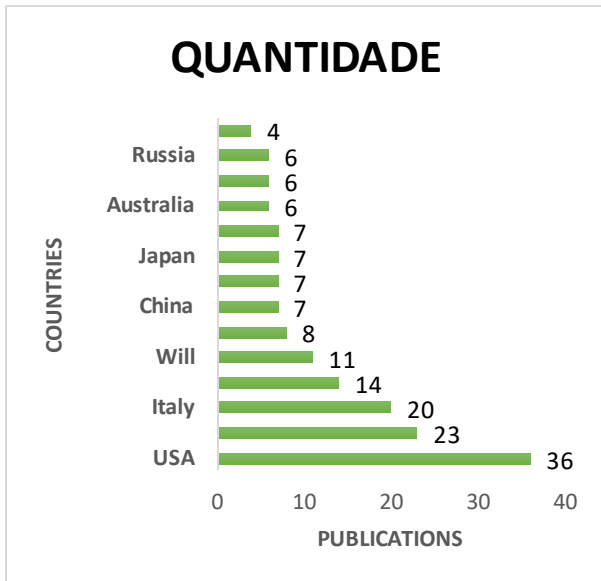


Fig.11: Graph of the countries with the highest frequency of publication.

Source: Adapted from Scopus (2019).

3.2.6 Knowledge Area

The data in Figure 12, shown below, graphically demonstrate knowledge areas with the highest frequency of publication on the subject.

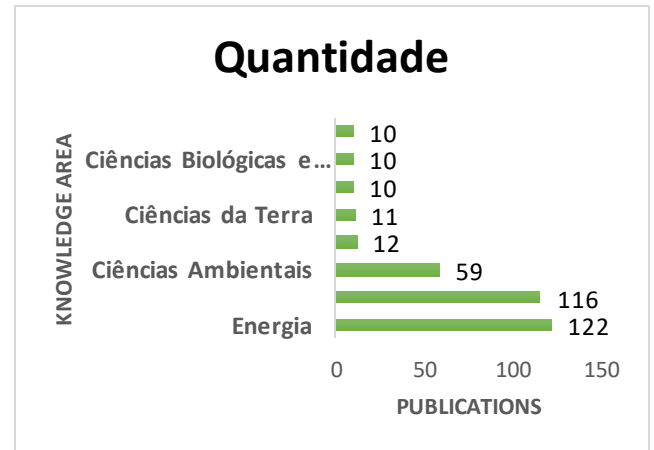


Fig.12: Graph of the areas of knowledge with higher frequency of publication.

Source: Adapted from Scopus (2019).

3.2.7 Analysis Articles

Table 3 presents the articles more relevantly, i.e. those with the largest number of citations, according to the database.

Table 3: Most relevant articles – Repowering

Title	Authors	Year	Citations
Batteryless, wireless sensor powered by the microbial fuel cell sediment .	Donovan, C. et al.	2008	202
Collision fatality of raptors in wind farms does not depend on raptor abundance .	LUCAS, M. et al.	2008	118
An option for solar thermal repowering of fossil fuel fired power plants .	Popov, D.	2011	91
Study and design of a hybrid wind-diesel-compressed air energy storage system for remote areas .	Ibrahim, H. et al.	2010	84
Efficient use of energy by utilizing gas turbine combined systems.	NAJJAR, YSH	2001	81

Source: Adapted from Scopus (2019).

3.3 Energy Innovation

For this session, the terms used for the research were "Energy Innovation". Applying the filter to articles, the search returned 199 results.

3.3.1 Publications by year

In Figure 13, you can graphically display the number of publications per year about energy innovation subject, in the 2000 to 2019 range.

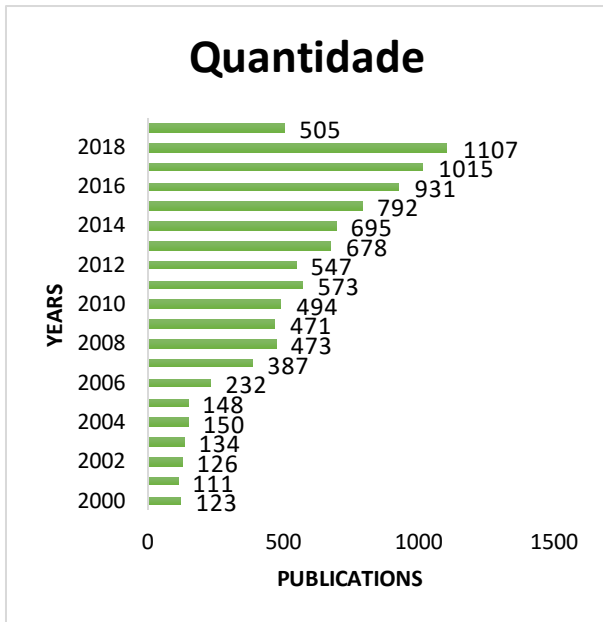


Fig.13: Frequency Plot of publications per year in the period 2000-2019.

Source: Adapted from Scopus (2019).

3.3.2 Authors

The authors most frequently published on Small Hydro Power in the range 2000 - 2019 are shown in Figure 14.

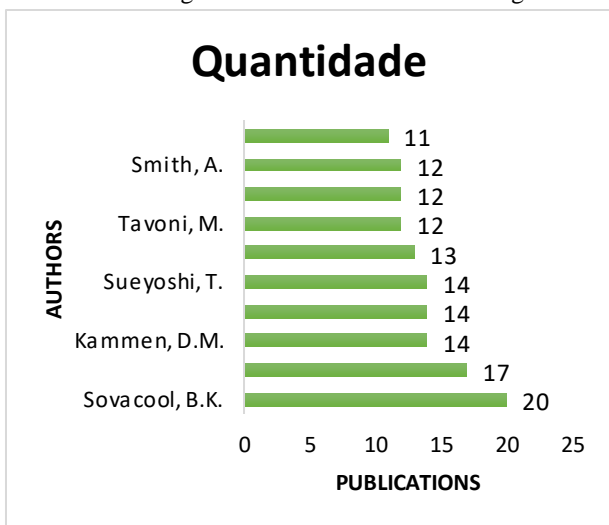


Fig.14: Graph of authors with higher frequency of publication.

Source: Adapted from Scopus (2019).

3.3.3 Journals

The data about which newspapers had the highest frequency of publication on the subject are illustrated graphically in Figure 15.

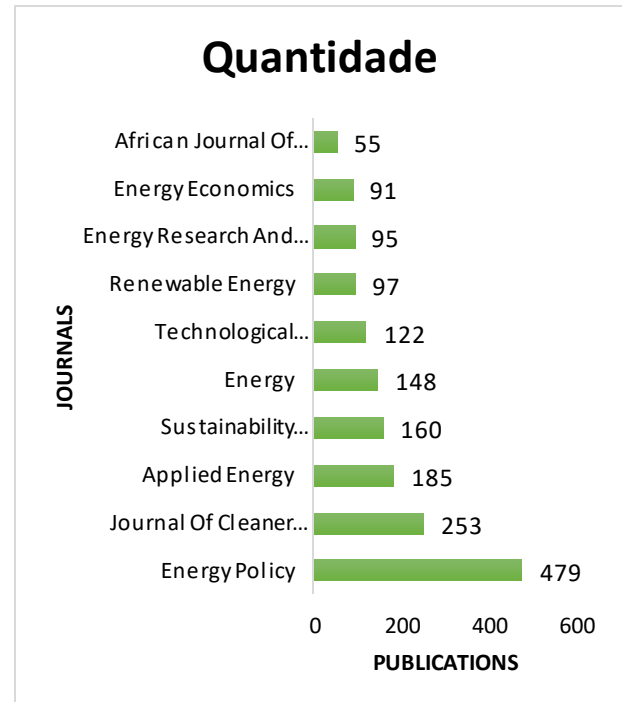


Fig.15: Graph periodic higher frequency of publication.

Source: Adapted from Scopus (2019).

3.3.4 Membership

The affiliates who contributed to the publications are illustrated graphically in Figure 16.

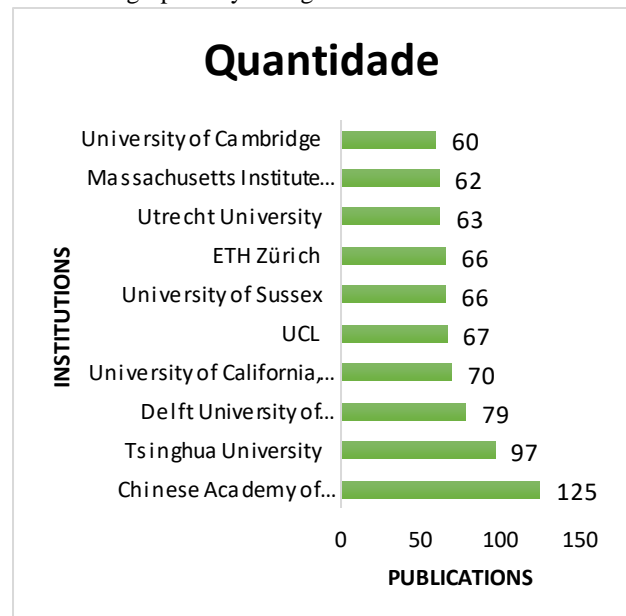


Fig.16: Graph institutions with higher frequency of publication.

Source: Adapted from Scopus (2019).

3.3.5 Countries

In Figure 17, below, are graphically represented the countries that contributed to publications in this period.

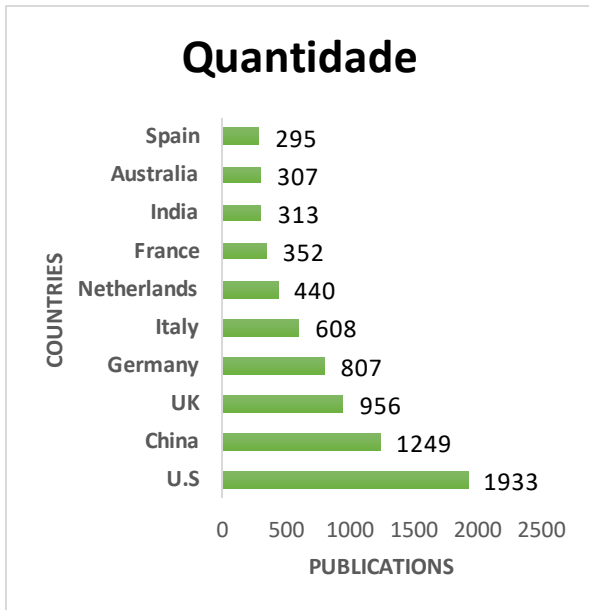


Fig.17: Graph of the countries with the highest frequency of publication.

Source: Adapted from Scopus (2019).

3.3.6 Knowledge Area

The data in Figure 18, shown below, graphically demonstrate knowledge areas with the highest frequency of publication on the subject.

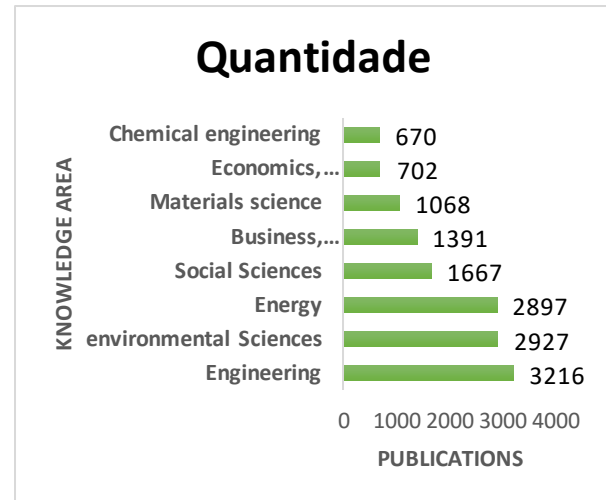


Fig.18: Graph of the areas of knowledge with higher frequency of publication.

Source: Adapted from Scopus (2019).

3.3.7 Analysis of Articles

Table 4 presents the articles more relevantly, i.e. those with the largest number of citations, according to the database.

Table 4: Most relevant articles - Energy Innovation

Title	Authors	Year	Citations
<u>The Swift Gamma-Ray Burst Mission</u>	Gehrels, N. et al.	2004	2302
<u>Microfibre-nanowire hybrid structure for energy scavenging</u>	Qin, Y., Wang, X., Wang, ZL	2008	1111
<u>Coordinated development of leading biomass pretreatment technologies</u>	Wyman CE et al.	2005	929
<u>Social acceptance of renewable energy innovation: An introduction to the concept</u>	Wüstenhagen, R., Wolsink, M. Burer, MJ	2007	882
<u>Polymer-derived ceramics: 40 Years of research and innovation in advanced ceramics</u>	COLOMBO, P. et al.	2010	816

Source: Adapted from Scopus (2019).

3.4. Sustainable development

For this session, the terms used for the research were "Energy Innovation". Applying the filter to articles, the search returned 199 results.

3.4.1 Publications by year

In Figure 19 it is possible to graphically display the number of publications per year about energy innovation subject, in the 2000 to 2019 range.

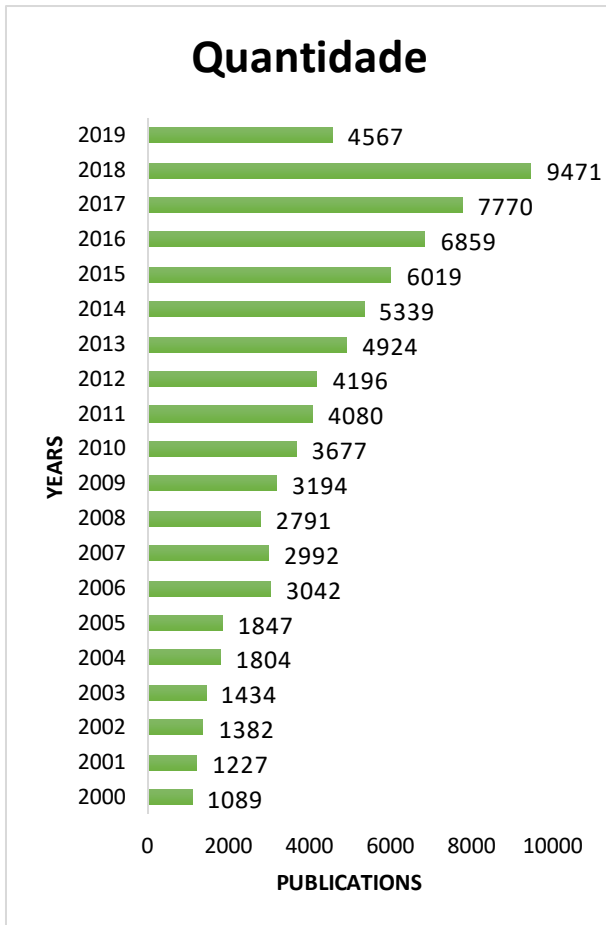


Fig.19: Frequency Plot of publications per year in the period 2000-2019.

Source: Adapted from Scopus (2019).

As shown in Figure 19, the number of publications on sustainable development has evolved over the past twenty years.

3.4.2 Authors

The authors most often published on Sustainable Development, in the range 2000 - 2019 are shown in Figure 20.

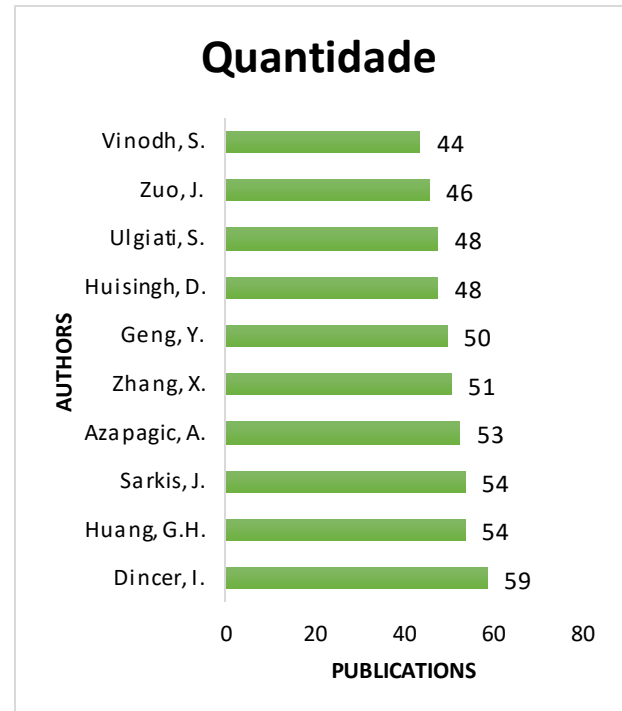


Fig.20: Graph of authors with higher frequency of publication.

Source: Adapted from Scopus (2019).

3.4.3 Journals

The data about which newspapers had the highest frequency of publication on the subject are illustrated graphically in Figure 21.

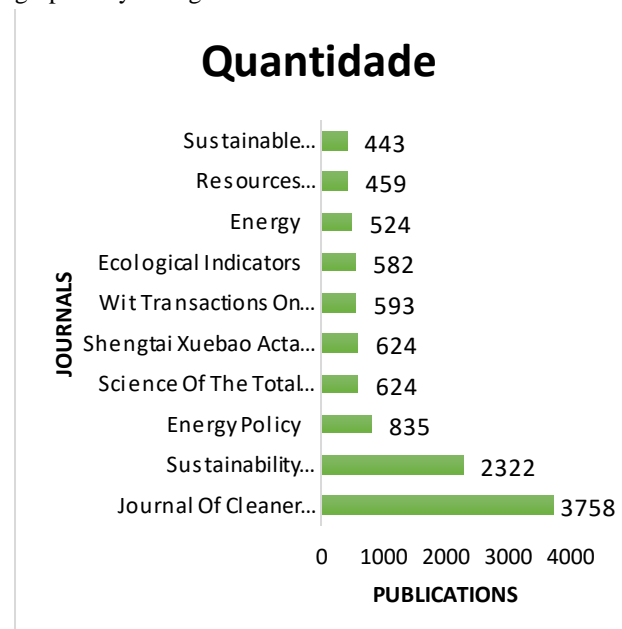


Fig.21: Graph periodic higher frequency of publication.

Source: Adapted from Scopus (2019).

3.4.4 Membership

The affiliates who contributed to the publications are illustrated graphically in Figure 22.

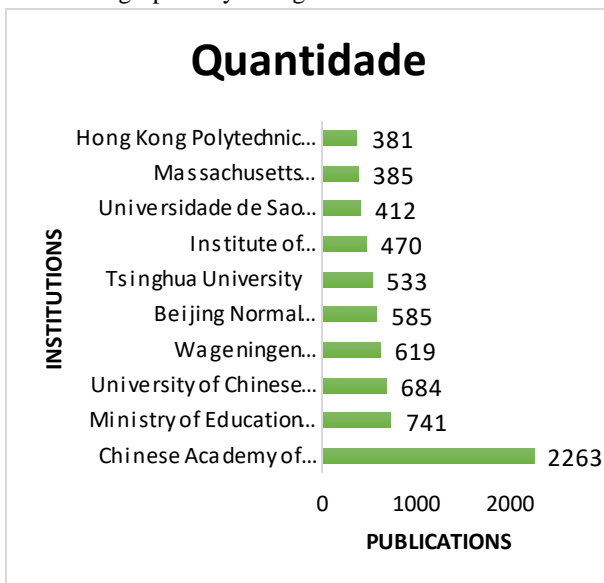


Fig.22: Graph institutions with higher frequency of publication.

Source: Adapted from Scopus (2019).

Dealing with sustainable development, the institutions that most frequently contribute to publications, are Chinese, especially the Chinese Academy of Sciences, with 2263 publications.

The University of São Paulo (USP) also obtained relevant figures, totaling 412 publications on the subject.

3.4.5 Countries

In Figure 23, below, are graphically represented the countries that contributed to publications in this period.

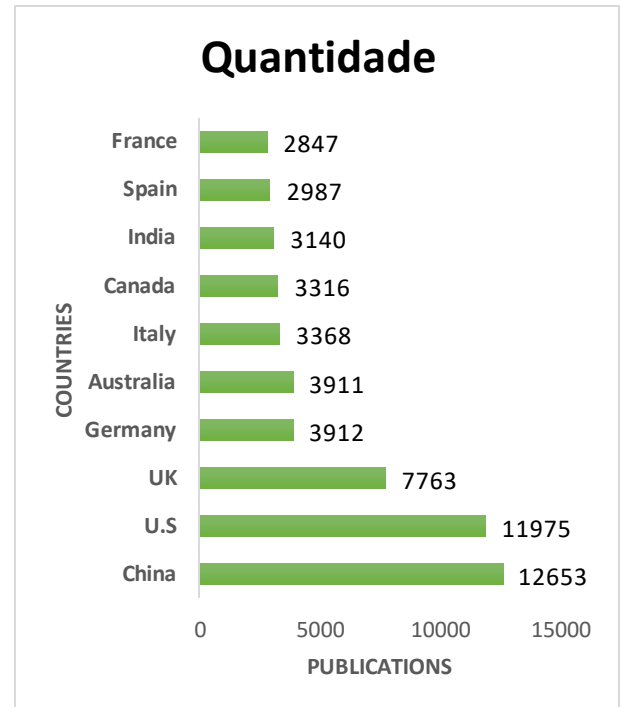


Fig.23: Graph of the countries with the highest frequency of publication.

Source: Adapted from Scopus (2019).

3.4.6 Knowledge Area

The data in Figure 24, shown below, graphically demonstrate knowledge areas with the highest frequency of publication on the subject.

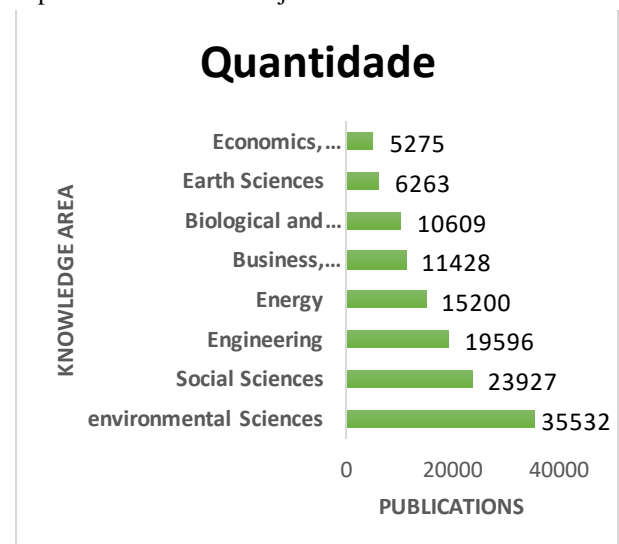


Fig.24: Graph of the areas of knowledge with higher frequency of publication.

Source: Adapted from Scopus (2019).

3.4.7 Analysis of Articles

Table 5 shows the most relevant articles with, namely, those with the highest number of citations, according to the database.

Table 5: most relevant articles - Sustainable Development

Title	Authors	Year	Citations
<i>Explicating dynamic capabilities: The nature and Microfoundations of (sustainable) enterprise performance .</i>	<u>Teece, DJ</u>	2007	3234
<i>Solutions for the cultivated planet .</i>	FOLEY, JA et al.	2011	2368
<i>Adaptation, adaptive capacity and vulnerability .</i>	Smit, B., WANDEL J.	2006	2095
<i>From a literature review to a conceptual framework for sustainable supply chain management.</i>	SEURING, S. Muller, M.	2008	2027
<i>Social and ecological resilience: Are they related?</i>	<u>Adger, WN</u>	2000	1544

Source: Adapted from Scopus (2019).

IV. CONCLUSION

In this work it was possible to check and analyze aspects related to Small Hydropower Plants, interventions via Repowering, Energy Innovations and Sustainable Development, in view of the objective.

The study bibliometrical technique is effective, together with the choice of a suitable database, in this case, Elsevier Scopus. In this study, it was decided to collect data on the number of publications per year, authors, journals, institutions, countries and areas of knowledge, but this is not a rule, the methodology can be applied to other variables.

Countries with higher frequency of publications were the United States and China, the latter being what else had articles related to small hydropower plants. Brazil also presented excellent figures in this subject.

Importantly, the repowering of small Hydropower energy is inseparable from innovation and sustainable development, in view of the great benefits that the investment in this renewable energy source brings to the national energy matrix and, consequently, for the whole society.

Finally, it appears that an increasing number of papers related to the topics covered in this article, proving that has increased worldwide, the need to achieve "optimum use" of water resources, whether in developed countries, where much resources have been exploited, in Brazil, where there is still great potential to be tapped.

REFERENCES

- [1] National Electric Energy Agency (2019). ANEEL. Bank of Generation Information: Brazil's generation capacity. Available at: <<http://www2.aneel.gov.br/aplicacoes/capacidadebrasil/capacidadebrasil.cfm>>. Access: 3 June.
- [2] ARAUJO, Carlos Alberto. (2006). Bibliometrics: historical development and current issues. In Question, Porto Alegre, v.12, n. 12, p.11-32, jan / jun.
- [3] Brazilian Association of Clean Energy Generation - ABRAGEL. (2017). Challenges Seminar on Electricity Generation in Brazil (ANEEL). Brasilia, 2017. Available at: http://www.aneel.gov.br/documents/10184/15266087/painel+3+ap+4+ABRAGEL++2017-10-19++Semin%C3%A1rio+Challenges+of++++Generates%C3%A7%C3%A3o+of+Energy++++El+%C3%A9trica+Brasil_ANEEL.pdf+the+/+a5822d40-a750-7434-6905-9a53c971b951. Access: 20 October 2018.
- [4] COSTA, H. (2010). Model for webibliomining: Proposal and application case. Rev. FAE, Curitiba, Volume 13, n.1, pp. 115-126, Jan./June.
- [5] Energy Research Company - EPE. National Energy Plan 2030 v. 12, Brasília, 2007.
- [6] Energy Research Company - EPE. (2017). Ten Year Plan for Energy Expansion 2026 Brasilia: MME / EPE7. Available at: <<http://www.mme.gov.br/documents/10584/0/PDE2026.pdf/474c63d5-a6ae-451c-8155-ce2938fbf896>>. Access> 20 October 2018.
- [7] FONSECA, EN. (1986). Bibliometry: theory and practice. São Paulo, Cultrix; Typeset USP, 141p.
- [8] OLIVEIRA, MA. (2012). Repowering Small Hydropower: technical and economic evaluation. 2012. 195 p. Dissertation (Masters in Energy Engineering) - Federal University of Itajubá.

Setup Time Optimization in the Roll-Up Process on a Motorcycle Buffer Production Line Using Kaizen

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Abstract— This article presents the application of Kaizen, through the implementation of a device that reduces setup time in the routing process of a production line of shock absorbers for motorcycles in the factory Amazon Motocycle Ltda, installed in the industrial hub of Manaus. Through field research the problem was identified. Kaizen reduced process setup time and increased productivity. In this way it was possible to improve the efficiency of the process in the production line by 50%, to gain productivity and to guarantee customer satisfaction.

Keywords— Kaizen, Device Implementation, Productivity increase.

I. INTRODUCTION

Seeking excellence in their daily manufacturing processes, companies have been forced to seek the improvement of their processes and ensure even more the quality of what is being produced. In the production process, several factors contribute to the accomplishment of daily tasks, which are qualified labor to handle machines correctly, tools appropriate to the process and a rigid control of how the production process is being executed, in order to gain productivity and avoid unnecessary costs for the company.

The present study will present Kaizen's application in the production process in the assembly line of shock absorbers at the company Amazon Motocycle Ltda, located in the industrial hub of Manaus for ten years, with the implementation of a device in the process of roller drive of the shock absorber. This improvement reduced the process setup time from ten minutes to five minutes, thereby increasing production line productivity and generating more profits for the company.

According to [1], companies exist to generate results, and these results are the final products generated from numerous activities called processes. The continuous improvement has as starting point the need to increase efficiency and effectiveness, the results of the activities carried out by the company's professionals.

In order to optimize the set-up time in the assembly line of shock absorbers, more specifically the roller routing process of the shock absorber, there was a lack of a device that facilitated the adjustment of the machine at the time of the setup, that is, at the time of changing a model from buffer to another.

Given this, the lack of a device to facilitate the setup resulted in a ten-minute stop line for adjustment, which led to loss of production and consequent generation of costs for the company, since it was necessary to reach the production plan with overtime after employees.

In view of the above, the present study aims to increase the productivity of shock absorbers and reduce costs with production delays. Thus, it aims to gain productivity by reducing setup time, maintaining and controlling quality, and reducing costs with production losses.

Field research was used to know the damper routing process, the quantitative research to obtain the number of the loss of productivity with the stop of the line for setup, the bibliographic research in books, in order to obtain information on the problem addressed in this study.

II. THEORETICAL REFERENCE

It will be presented the theoretical reference on the process of continuous improvement and kaizen philosophy.

2.1 Continuous Improvement

Companies seek continuous improvement every day to maintain their prices and achieve the highest quality of their products or services, and for this they use the quality tools in the search to find the improvement that their daily manufacturing processes need.

In the productive process, it is necessary to have a systemic view, where it is possible to always be seeking improvement of the processes and that these improvements can be implemented in the shortest time possible, to increase productivity, improve the performance of the productive sector, but without losing the focus on product quality and through that, bring better results to the company.

Regarding processes, [2] says that for productivity improvement, an excellent tool is process management, and with this tool it is possible to have a better use of the people involved in the process, especially the managers responsible for the production of the products, in order to obtain better results from the daily activities of the company. In order to use this tool, it is indispensable to know well the processes performed and apply, aiming at continuous improvement, reduction of losses and increase of productivity.

The implementation of the improvement in the assembly line of shock absorbers, arose from the great knowledge of the management about its daily processes, as with the increase of the daily production, a better performance of the production line was needed and the people involved with the continuous improvement, aiming to bring better productivity indicators. Putting into practice what [2] mentions the main steps for the correct functioning of the management system, which includes: planning, controlling, reporting and evaluation. For the four steps to work correctly, it is necessary to bring together the people involved in the improvement processes and actions and to show the results achieved, if necessary, re-evaluate what was planned.

2.2 Kaizen For Increased Productivity

On productivity, [3] says that productivity is the production in relation to the time of production with direct labor, where it aims to increase productivity, without labor costs, in order to seek better yields with the efficiency in the processes productive.

For [3], planning or execution is not enough, it is necessary to control and monitor their performance and their results in this productive process, to ensure that they are satisfactory. For this, a rigorous monitoring of the degree of efficiency and effectiveness is necessary, to make corrections in the shortest time possible. All this

process will result in more agility and flexibility of the productive process.

Agility in the process, is the purpose of the implementation performed on the assembly line of motorcycle dampers, seeking to improve the process, but maintain the excellent quality of the shock absorber produced. For this, controlling the improvement made was essential to achieve the expected results.

The companies aim to reduce costs and optimize their processes, in this sense continuous improvement is essential, because through these improvements in the production process, the reduction of waste raw materials, time with rework and activities is achieved which do not add value to the company.

Continuously improving processes is to optimize your production processes, reducing unnecessary time and avoiding production costs for the company, and especially, not passing these costs on to the customer.

According to [1], continuous improvement seeks the constant improvement of organizational processes and the great goal of continuous improvement is to increase its capacity to effectively serve its customers, improve their processes and increase productivity without losing focus of quality. product.

For [3], the main objective of continuous improvement is to interfere or even modify factors related to the performance of a process, in order to obtain the expected result.

Bringing the concept addressed by the authors about continuous improvement, the implementation of a device that reduced setup time in the damper routing process was a way to improve the performance of the process, increasing its productive capacity and reaching an expected result that was the daily production gain.

In his work [1] he mentions that the process of analysis and improvement of process, aims to identify the process or group of processes that are not functioning properly and, with this, damaging the performance of the organization.

According to [4], obtaining information about the process performance, analyzing the outputs of the products generated by the processes is important, however, the best information about the behavior of the processes will be obtained by analyzing each process one by one, monitoring their variables and their performance. Having stipulated a goal to be achieved by each process in a production line, for example through this analysis and the collection of correct data, one can verify if there are abnormalities in the process and can apply the necessary actions for its correction. Also in this context, for [5], there are two types of actions, those made in the middle

of the process, where they are generally the most economical, because they prevent variations and prevent the characteristics of the process from distancing themselves from the values stipulated by the company. On the other hand, the actions performed in the output generate results, but they are more expensive because they will have to understand which process is abnormal and it will take more time to find its root cause and take the action of containment.

Taking into account Machado's citation, this concept of analyzing the processes according to their characteristics was the essential one to identify the problem in the process of the damper routing, since it was the only process in which production was lost due to setup delay, and through concrete data collection the improvement was applied with the introduction of a device that lowered the time spent in case of a model change in the production line.

In his work [6], he mentions that in the productive process, when something does not go as planned, one must seek to understand the reasons for not reaching planning, in which four steps are important:

- Analyze and show what exactly is making the process difficult;
- Record the difficulties as documented information to move to the responsible management of the processes;
- Communicate, through documented information, those responsible, in order to obtain the subsidies to take the improvement actions;
- Perform the improvement actions to correct and prevent the problems in the processes.

For [7], it says that the work of process analysis and improvement, aims to identify the process or group of processes that are not functioning properly, hampering the performance of the organization.

In his work [8] raises important questions to be asked to obtain knowledge regarding the processes, such as:

- Where the process begins;
- What activities occur during the process;
- Method of how activities are developed in the process;
- What inputs are used;
- What is its execution time;
- Who is directly responsible for the process

Regarding the authors' citation, if a production line has a goal to be fulfilled daily and the processes have a setup time and if for some reason the results are not expected, something is abnormal and this at the end of the day, month or year, causes a huge loss to the company, since the loss of productivity entails enormous losses for the company. So it is necessary to do a very detailed

analysis of the process in order to discover the ones ready to make the correct improvements and avoid greater losses of productivity in the process.

For [9], three actions are extremely important for the control of processes:

- Establish control planning, which will include the goal of desired values and the methods that will be used to achieve process control;
- Maintaining the control level, once the control is reached, maintenance is necessary. If it is not maintained, one must review the methods used to discover the root causes and make a new treatment for its proper functioning;
- Changing your control guideline, where you must change the procedures to achieve your level of control.

III. SCIENTIFIC METHODOLOGY

For the elaboration of this study, we used bibliographical research in books, the field research with the quantitative research method and informal interview with the assembly line manager of shock absorbers.

For [10], a field of extreme importance in the bibliographical survey is the field research, because it will provide a great review of the literature on the subject. The bibliographic research determines the objectives, the construction of hypotheses and help offering elements to support the choice of the theme proposed by the study.

In the field survey, we analyzed the production plan of the assembly line of shock absorbers, and observed all the processes, in order to raise the data for the implementation proposal. In this observation, it was identified the problem in the process of roller drive of the damper, where it was wasting a lot of time in the setup and damaging the closing of the daily production plan. Then, improvement was implemented through a device that facilitated the exchange of one model to another with a shorter time.

According to [11], field research relies on specific techniques that seek the objective of obtaining information or seeking knowledge about a problem, in which a response is sought, a proof or discover the relationships between them.

Through the field research, the processes were observed in the assembly line of the buffer, as it helped to collect the data referring to the problem addressed by the study. With the quantitative research, data were obtained through documents that show the significant productivity losses with the high setup time of the damper routing process.

In order to obtain more information on the problem of the high set-up time and the loss of productivity in the

assembly line of shock absorbers, an interview was conducted with the production line manager, who reported and showed productivity losses with the process setup. In the interview it was suggested to implement another device that facilitated the exchange of one model to another, reducing this setup time and gaining productivity.

3.1 Company Characterization

The present article on the reduction of setup time in the routing process in a production line of motorcycle dampers was carried out at the company Amazon Motocile Ltda, located in the Industrial Pole of Manaus. The company has been operating for 10 years in the market and has 1,600 employees.

Amazon Motocile Ltda, manufactures rear and front shock absorbers, top table, steering column for motorcycles and has as customer the largest motorcycle manufacturer in Brazil.

To provide excellent products to its customer, the company has high-tech machinery to produce its products that undergo a rigorous testing system such as Damping machines to ensure its functionality and breakout tests to ensure the safety of the motorcycle driver .

The company is the only one in the world to introduce the first front spring without spring on one side, proving once again that with studies and technology in its favor, it can stand out from its competitors, keeping the its excellent quality of its products. For this, its employees receive constant training to improve their knowledge and

to be able to perform their daily activities with better performance, with focus on safety and quality.

IV. RESULTS ANALYSIS

The problem of the loss of productivity in the assembly line of shock absorbers with the high setup time in the roller routing process of the shock absorber, the implementation was to install another device that facilitated the exchange, in case of change of models in the production line. This device reduced setup time from ten minutes to five minutes, thereby reducing productivity loss and increasing production line efficiency and lowering costs for the company by reducing overtime to achieve the daily production schedule.

For the better understanding of the implementation, we used the quality flowchart tool, where it will show the whole process of the damper assembly and the flowchart of the damper routing process, showing the before and after the implementation of the device. The graphs will also be shown, showing the losses before device implementation and the gain in productivity after the implementation of the device.

According to [12] and [13] the use of flowcharts aims to identify possible causes of problems that occur in manufacturing processes, verifying unnecessary tasks in the process or making improvements.



Fig. 1: Flowchart of the damper assembly process

Analyzing the assembly process of the damper, shown in the flowchart, and seeking to improve productivity, because it was not possible to close the daily production plan, in this search, the bottleneck of parts that returned to the beginning of the line was identified, mainly in the start of the shift and in model exchanges.

In order to identify this problem more deeply, the production time of each process was removed in order to discover the true root cause and which process was delaying productivity. Table 01 below shows the times of each process on the damper assembly line.

Table 1: Buffer assembly process time

Process Times					
Default time: 09 seconds					
Process	Machine Time	Man Time	N° of Parts	Total Cycle	Neck
Pre-assembly of the valve	0	6	1	6,0	9,0
Piston pre-assembly	0	8	1	8,0	9,0
Riveting	5	3	1	8,0	9,0
Spring / Retainer Introduction	0	7	1	7,0	9,0
Oil Injection	3	4	1	7,0	9,0
Damper routing	7	2	1	9,0	9,0
Damping	5	2	1	7,0	9,0
Introduction of Spring	1	4	1	5,0	9,0
Support Torque	7	1	1	8,0	9,0
Bucha Introduction	2	5	1	7,0	9,0
Final Inspection / Storage	0	8	1	8,0	9,0

At the end of the analysis of the process times, it was identified that the damper routing process worked on the bottleneck, that is, at the limit of the process time to process a part.

At this default time of 9 seconds per piece, the operator can not waste any time, otherwise passes raw parts without the roller routing of the shock absorber. It was also identified that the process had setup time of ten minutes, in the exchanges of models, and the others were doing their setup in five minutes.

Regarding this programmed loss, that is, the setup, the company already has as programming this loss of five minutes of stop for adjustments of each process in case of changes of models, resulting in thirty-three pieces lost for the setup. However, the roulette process was set up for ten minutes, twice the time programmed by the company, that is, losing sixty-six pieces, 50% more than scheduled.

Before this confirmation of the setup time, another analysis was done on how to improve the process and reduce this time, in seeking and gaining this lost productivity. In this improvement process, the production line management was involved, along with the company's Kaizen team.

In this search for the solution, and analyzing the roller rotor of the shock absorber, it was concluded that the method of changing the adjustment device of the machine was making difficult the quick change in the time of the setup, thus affecting the productivity at the end of the day.

To solve this problem and perform the necessary improvement, another machine adjustment device was designed and designed by the company's technical design team. The idea was that the new device would facilitate and speed up the adjustment of the machine in case of model changes, making the process agile and productive.

The implementation of the adjusting device has significantly reduced productivity loss because the operator is able to perform its setup time within the time of up to five minutes, which is the time of the other damper assembly processes as well, reducing the loss of productivity in the process.

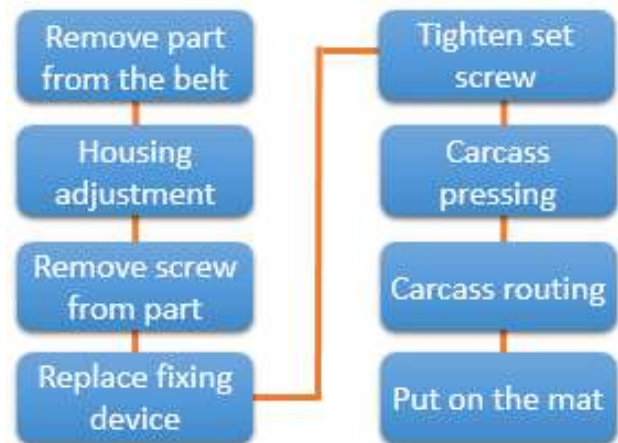


Fig. 2: Rotation process before device deployment

The flowchart in Figure 02 demonstrates the roller routing process of the damper before the implementation of the new device for improvement.

Figure 03 below demonstrates the setup process on the damper rotor machine.



Fig. 3: Damper attachment device

It can be observed before the implantation of the improvement device, where the operator makes multiple adjustments in the machine in case of a model change in the production line.

Shown in Figure 4, the flow chart of the damper routing process, after the implementation of the device.



Fig. 4: Process flowchart after device deployment

In this process the activities that did not add value to the process were reduced, and the activities in the posts were redistributed.

Figure 5 below demonstrates the change of device in the roulette machine with the improvement achieved through a new fastening device where the operator only withdraws a dowel pin from the device to perform a change from one model to another, reducing the time setup and gaining productivity.



Fig.5: New damper attachment device

Regarding the new device, in addition to facilitating the exchange of one model for another, the significant reduction was the time from ten minutes to five minutes of machine stopped for adjustments, increasing the efficiency of the process with the focus on the daily production productivity gain. These five extra minutes in the setup resulted in a significant loss of thirty-three pieces at each model exchange for machine adjustments and production reporting,

Table 2 is based on the year 2018 and shows the monthly production of shock absorbers in the production line in the year.

Table 1: Monthly production of shock absorbers - year 2018

Production of shock absorbers year 2018	
Month	Produção Mensal
January	67.200
February	61.500
March	98.400
April	82.000
May	88.200
June	52.000
July	66.300
August	89.700
September	72.000
October	84.000
November	69.700
December	56.000
Total Production	820.700 Peças

Based on the production of shock absorbers in the first six months of 2018, the graph of Figure 6 demonstrates

the monthly loss of parts due to the high set-up time in the roller routing process of the shock absorber, where there was a ten minute machine time stop for adjustments, 50% more than programmed. The data shown in the chart in relation to the losses are only due to the roller routing process of the damper and its setup time, with a daily loss of 33 pieces in the first seven months of 2018.

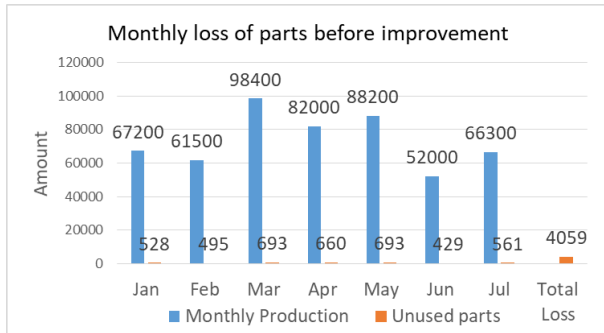


Fig. 6: Loss of parts before improvement

According to graph data, it is possible to visualize the great loss of productivity, due to a single process and its high setup time. The total loss shown is a huge loss to the organization, because in order to achieve its productivity goal, it needed to have overtime, generating more expenses and affecting its profitability.

With the implementation of the new device, to facilitate the exchange of one model to another at the time the setup, a significant reduction of 50% in time was obtained, leaving a setup time of ten minutes to five minutes, totally reducing the loss with high setup time.

The graph in Figure 7 demonstrates the production in the last 5 months of 2018, showing the Kaizen result in the process of damper routing with the implementation of an adjustment facilitation device at the time of the process setup.

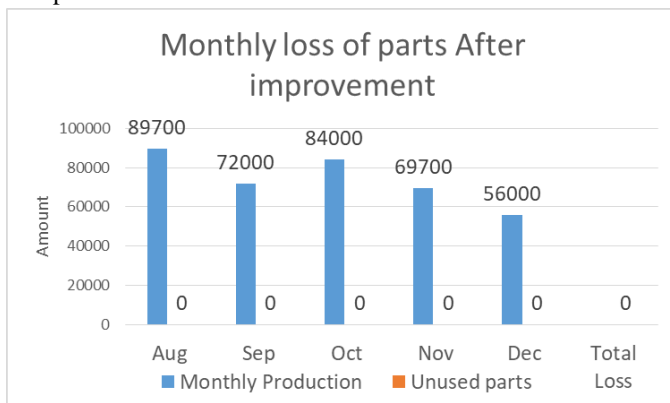


Fig. 7: Loss of parts after improvement

As shown in the chart, after the implementation of the new machine adjustment device, the daily losses of thirty-three pieces have been eliminated, as the operator by

means of the fast adjustment of the roulette machine, can make its setup in five minutes, thus improving the process performance and gaining productivity.

V. FINAL CONSIDERATIONS

The main purpose of this study was to present a Kaizen in the production process in a production line of motorcycle dampers, more specifically in the process of damper routing.

The improvement was based on studies, analyzes, interviews with production operators and area managers, carried out at Amazon Motocycle Ltda. Through the analysis of the process times and observation of the production process, it was verified the high setup time in the roller routing process of the shock absorber, where the improvement work was carried out, with the implementation of a new machine adjustment device that facilitated and accelerated the in case of a change from one model to another.

The main gain with the implementation of this device is the productivity at the end of the day, the month, the year, as it ended the daily loss of thirty-three pieces, coming from ten minutes of setup, where the ideal setup is five minutes.

The quest for continuous improvement and process innovation is a method that every organization should do to improve its processes and stay in the highly competitive market, where it is tirelessly seeking to reduce costs and increase productivity.

The improvement implemented in the process, reduced the losses in the process setup by 50%, keeping the loss scheduled for setup within the time stipulated by the company. The application of Kaizen in the process brought increased process efficiency and increased productivity.

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REFERENCES

- [1] LUCINDA, Marco Antônio. Qualidade: fundamentos e práticas para cursos de graduação. Rio de Janeiro: Brasport, 2010.
- [2] PARANHOS FILHO, Moacyr. Gestão da produção industrial. Editora Ibpe, 2016.
- [3] CHIAVENATO, Idalberto. Gestão da Produção: uma abordagem introdutória. 3. ed. Barueri: Manole, 2014.

- [4] MACHADO, José Fernando. Método estatístico: gestão de qualidade para melhoria contínua / José Fernando Machado. São Paulo: Saraiva, 2010.
- [5] PALADINI, Edson Pacheco. Gestão da qualidade: teoria e prática. In: Gestão da qualidade: teoria e prática. 2010.
- [6] LOBO, Renato Nogueirol. Gestão de Produção. São Paulo: Érica, 2010.
- [7] CAMPOS, Vicente Falconi. TQC: Controle da Qualidade Total (no estilo japonês). Universidade Federal de Minas Gerais, Escola de Engenharia, 1992.
- [8] CRUZ. T, Sistemas, organização e processos: administração, organização por meio de processos de negócios, 2º ed., Atlas, São Paulo 2009.
- [9] NISE, Norman S.; DA SILVA, Fernando Ribeiro. Engenharia de sistemas de controle. LTC, 2002.
- [10] ANDRADE, Maria Margarida de. Introdução à metodologia do trabalho científico: Elaboração de trabalhos na graduação. 9. Ed. São Paulo: Atlas, 2009.
- [11] LAKATOS, Eva Maria; MARCONI, Marina de Andrade. Fundamentos de Metodologia Científica. 7. ed. São Paulo: Atlas, 2010.
- [12] RAMOS, A.W. CEP para Processos Contínuos e em Batelados. São Paulo: Fundação Vanzolini, 2000.
- [13] MACHADO, José Fernando. Método estatístico: gestão de qualidade para melhoria contínua / José Fernando Machado. São Paulo: Saraiva, 2010.

A Secured Frame Work for Searching and Sharing of Data in Cloud Based Services using IoT

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Abstract— The internet technologies evolved many new innovations in communication technologies for searching and sharing data over the IoT. The importance of both software and hardware technologies became an important for the service providers and users as well. Searching and data sharing is contemporary task for the services providers because security aspects. Efficient searching and secured data sharing is an open issue till now. Information leakage costs more for the organizations. In this paper we propose an efficient frame work for secured cloud based services where the data can be shared among multiple devices of IoT. Our scheme allows all smart devices to interact and share data among users in Internet of Things securely. We also attempted to develop a useful searching mechanism for having required data by the users over distributed storage domains to share. We conducted an abundant survey and study them in depth for better improvement of our work.

Keywords— IoT, cloud based services, AES, DES, key generation, SHA.

I. INTRODUCTION

The Internet of Things is one of the internet revolutions which provide a platform for all real world smart devices to connect and use the internet for searching and data sharing among various users. Various studies tell that by the end of the 2020 there would be great improvement in the usage of internet through smart devices. One of the studies of the CISCO¹ reveals that more than 50 billion smart devices are going to share the internet through various smart devices. The challenge for this act is to provide a compatible environment by the time with capable searching and secured mechanism. It further extends to smart grids, smart technologies in the domains of homes, cities, medicine, healthcare systems, transport systems etc.

These heterogeneous smart devices will establish a platform for generating large volumes of data. The generated data will be stored in cloud. To access the cloud data highly computational techniques are required for searching, processing the data in shared platform with an efficiency and security. There will be a contradiction, smart devices have limited capacity but cloud services are virtual i.e. unlimited capabilities hence by using IoT this can be resolved some extent. IoT services required low latency, high data rate, fast data access, and real-time data analytics/processing with decision-making and mobility support of smart devices. It is one more gap for

efficient searching and data sharing in cloud based services.

II. RELATED WORK

The objective of this paper is to provide proper searching and sharing data among users over cloud based services using IoT. Many smart devices are available in the market and easy to connect internet to access required data from cloud. The main focus is sharing of data among multiple smart devices which leads to compatibility and extensibility of their services for efficient searching techniques. The generation of internet technologies crossing rapidly like 2G to 5G etc. there may be expected phenomenon for device technologies.

In this paper we tried to give some possible solutions for efficient searching and with secured data sharing over the smart devices in cloud based services using IoT. The existed encrypted and decrypted security mechanisms performed well and the same we are extending for the problem like symmetric, public key and homomorphic encryptions used. For the controlling of access control used control list and dynamic attributes are used. Key encryptions are used for searching data for IoT. This is an extra burden to the smart devices hence heavy computational process is required.

By considering all the mentioned limitations there may be a need of an alternative solution is required. Hence we proposed a lightweight cryptographic mechanism for

security issues for smart devices of IoT. Our mechanisms performed well while sharing of data with other smart devices in IoT. Data searching can control when allowed authorized users then performance of the devices also increased which reduced heavy computational and communication capabilities.

We focused on the

1. Implementation of secure data-sharing scheme for cloud connected IoT smart devices.
2. Development of efficient searching techniques for users required data with authorized users for reducing computational and communication capabilities.
3. Prosing of validation and verification process for user's retrieved data which increases the integrity and searching data efficiency well.
4. Finally performance analysis with our proposed methods for IoT applications.

III. LITERATURE SURVEY

Dario Bruneo, Salvatore Distefano [1] explained about various IoT service ecosystem for Smart Cities of the SmartMEproject, In this paper given results oriented solutions after 2 years , we present the results from environmental monitoring to parking management.

K. NarendraSwaroop a, KavithaChandu in [2] given a health monitoring system for vital signs using IoT, this article presents the design of a real-time health monitoring system which can store a patient's basic health parameters. Panagiotis I. Radoglou Grammatikis in [3] given few measures for securing the Internet of Things: Challenges, threats and solutions.

Sahitya.Roy ,Dr Rajarshi. Ray, IoT in [4] described the advanced technologies like Big Data Science & Analytics, Cloud Computing and Mobile App based Hybrid System for Smart Agriculture domain.

Andrea Zanella in [5] gave clear clarity about building of smart cities using IoT Internet.

ShahidMumtaz, Guest Editorial in [6] drafted the summary of a special issue on 5G and Beyond-Mobile Technologies and Applications for IoT.

Mohamed Kheir in [7] drafted a special issue on Intrinsic Hardware Security for Internet of Things Infrastructure.

Liuqing Yang in [8] explained about IoT on the move: Enabling Technologies and Driving Applications for Internet of Intelligent Vehicles (IoIV).

Jasmin Guth in [9] tells about a detailed analysis of IoT platform architectures: Concepts, Similarities, and differences, http://dx.doi.org/10.1007/978-981-10-5861-5_4.

We conducted an intensive survey from which we drafted the required things to use and modify technologies to improve our work. The survey is useful us to take make and decisions about our work to select things required. All the existed works explained well in many aspects but little back on explanation of searching and security aspects.

The rest of the paper is organized as follows. In the fourth section, we present the proposed work, section five explains data sharing and searching, section six given the performance analysis of the work, section seven describes various cryptographic mechanisms that are used in our proposed scheme. We then analyse the performance and compare it to related works. Finally, we conclude our paper by drafting the conclusion.

IV. PROPOSED WORK AND SECURITY ASPECTS

The proposed work concentrates various cryptographic techniques used and how they contributed to perform an efficient searching with security for shared data over the smart devices of IoT.

Cryptographic Technique	Description
Secret Key Encryption	By using secret key the user will send and receive secured data. Devices using secure communication principals.
Public Key Encryption	It is a two key mechanism, public key and a secret key. Public key can be used before sending data and secret key is used for decrypting the data.
Searchable Secret Key Encryption	It uses secret key by using trapdoor for authorized user devices only.
One Way Hash Algorithms	It is used for integrity check with hash functions i.e. if any data is modified between sender and receiver.
Digital Signature	Public and secret key are operated by the authorized users with digital signatures.

Our proposed work also explains the required overall architecture of the system for efficient searching and secured data sharing for cloud based services for IoT. The architecture is made up with the following entities shown in the below table.

Entity Type	Description
Smart Devices	Allow authorized devices to share searching data.
Server	Smart devices given privilege to

Technologies	connect to the servers must be located comfortably. Self oriented secured encryption and decryption can be done by the smart devices.
Certificate Authority	The certificate authority is fully trusted and is responsible for issuing certificates to edge servers.
Key Generation Mechanism	The public and secret keys can be generated by the third party servers to have security.

Here we focus on the various threats while sharing data among smart devices of IoT. Implicit threats generated by the system itself because of malicious functioning and explicit threats are generated by the unauthorized users using devices and is one more issues.

V. SECURE DATA SHARING AND SEARCHING FOR IoT

Here we perform efficient searching and secured data sharing for smart device of cloud based services via IoT by using our proposed scheme.

Algorithm Design Steps
Step1: All users must register and will be given user name and password
Step2: Allow the devices to download required data
Step3: Efficient searching for required relevant data
Step4: Then key generation for security aspects i.e encryption/decryption
Step5: Uploading of data and keywords for efficient searching
Step6: Allow devices to share and download data
Step7: Perform data retrieval and searching
Step8: Use digital signatures for data integrity
Step9: Safe searching and download for good performance by the authorized users
Step10: Controlling threats generations

Key Generation: The server will generate two secret keys first one is randomly generated secret key (256bit) and

Results Table

Table.1. Time processing of various techniques

Time For (ms) / Techniques	Encryption	Decryption	Digital signature	Total Processing
Key Generations	0.4	0.5	0.3	1.4ms
Data Uploading	1.6	2.0	1.2	4.8 ms
Data Downloading	1.2	1.8	0.7	3.7 ms
Data Searching and Retrieval	5.5	6.5	1.01	13.01 ms

We observed that the time factor is almost negligible irrespective of memory sizes, techniques used and other comparatively.

second one is Sec.Key (for data sharing) and S.Sec.Key (for data searching) from devices side uniquely.

Data and Keywords Uploading: Every smart device is given user name and password to login into the server then data searching, sharing and transferring data among devices and servers is possible. List uploaded keywords are useful to the authorized users to search easily. While uploading data into the server storages devices must be encrypted with respective keys for data integrity. Then works based on the table 1.

Data Sharing and Downloading: Authorized users are allowed to access the data from cloud to reduce the bottleneck and increase the performance. Authorized user can be given user name and passwords through which they connect to the server through their smart devices from various locations. Then the server checks the user authentication using its digital signatures. Then using keys data can be had by performing encrypted and decrypted techniques and unauthorized users will get rejected. It is compulsory to perform an integrity action for checking received data. If data was found or matched then users can download or share it.

Data searching and retrieval will also follow the above steps but use trapdoors for generating keys to an efficient search for every device.

VI. PERFORMANCE ANALYSIS

We used various encryption (AES, RSA and SHA-256) and decryption algorithms to generate secret key, public key and hash function development along with cipher chaining mode with respect to the processing time. The processing time was estimated for data decryption and encryption for various memory sizes of data (10 to 500MB) and calculated time process for key generation, data uploading, data downloading and searching and retrieval was given in the table 1. Data integrity was done in terms of valuation and verification of the transferred data in smart devices.

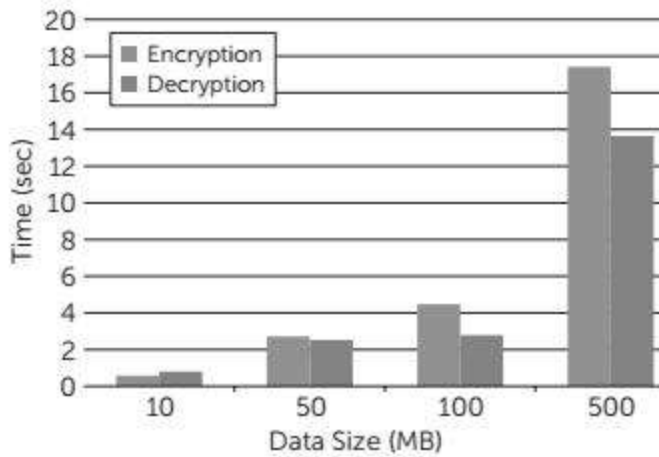


Fig.1. Processing time of encryption and decryption of AES.

VII. RELATED WORKS AND COMPARATIVE ANALYSIS

This section we performed comparative study with respect to the other works. We have gone through the various papers related this work in terms of consumption of time processing in [6,7] developed a certificate less proxy re encryption using symmetric and public key techniques.

Table.2. Comparative study of the existed works

Author Work	Comparative study
S.H. Seo in [10]	used certificateless scheme for data sharing but without bilinear pairing
Mohamed Kheir in [7]	The cloud is responsible for both secure data storage and public/private key pair generation.
Baqer Mollah In [13]	The data can be encrypted with the secret key and then the secret key is further encrypted with the public key and finally sent to the cloud server.
Khan in [6]	Utilized an incremental cryptography-based data sharing scheme where the data are divided into several blocks and these blocks are then incrementally encrypted.
Jasmin Guth in [14]	A trusted third party is used as a proxy for key generation, re-encryption, and access control purposes.
Ali in [15]	A secret key-based encryption and access control list for secure data sharing where a trusted third party is engaged in encryption/decryption, key management, and access control rather than the user's device itself is utilized.

Table.3. Comparison of total uploading time in seconds.

Data (MB)	Ref.9	Ref.11	Ref.10	Ref.12	Ref.13	Our Work
10	5.43	12.04	13.95	14.13	0.5612	0.4812
50	9.01	53.68	58.56	60.37	2.7162	2.1350
100	17.37	99.69	112.41	155.15	4.0213	3.9156
500	33.24	369.72	492.09	872.09	17.4262	16.9401

Table.4. Comparison of total downloading time in seconds.

Data (MB)	Ref.9	Ref.11	Ref.10	Ref.12	Ref.13	Our Work
10	6.48	9.91	9.90	10.45	0.8057	0.6037
50	10.24	33.45	35.57	35.90	2.5237	2.0273
100	20.68	57.14	59.14	61.59	2.7937	2.1806
500	39.25	215.3	229.81	400.21	13.6537	12.5637

VIII. CONCLUSION

Our work presents a novel approach for efficient data sharing and searching scheme for cloud-based services using IoT. We have gone through the various encryption and decryption techniques used in our work. When we compared the work, we feel that our work gives better performance than others. The processing time can be calculated based on the searching, data sharing and other parameters of the work. It is observed that when all the smart devices connected to the server will get bottleneck

gradually performance will decrease where as the performance analysis in section six and demonstrated results are tabulated in table 2 and table 3. We feel some reformations are required related to authentication and access control challenges in this area to achieve data integrity. We hope that our proposed scheme is deployed an efficient performance and opens a new era to cloud-based service using IoT secured applications.

REFERENCES

- [1] Dario Bruneo, An IoT service ecosystem for Smart Cities: The #SmartMEproject, *Internet of Things* 5 (2019) 12–33, © 2018 Elsevier.
- [2] K. NarendraSwaroop, A health monitoring system for vital signs using IoT, *Internet of Things* 5 (2019) 116–129, © 2019 Elsevier.
- [3] Panagiotis I. RadoglouGrammatikis, Securing the Internet of Things: Challenges, threats and solutions, *Internet of Things* 5 (2019) 41–70, © 2018 Elsevier.
- [4] Sahitya. Roy, IoT, Big Data Science & Analytics, Cloud Computing and Mobile App based Hybrid System for Smart Agriculture, 978-1-5386-2215-5/17 © 2017 IEEE.
- [5] Andrea Zanella, Internet of Things for Smart Cities, *IEEE INTERNET OF THINGS JOURNAL*, VOL. 1, NO. 1, FEBRUARY 2014.
- [6] Guest Editorial, Special Issue on 5G and Beyond—Mobile Technologies and Applications for IoT, *IEEE INTERNET OF THINGS JOURNAL*, VOL. 6, NO. 1, FEBRUARY 2019.
- [7] Guest Editorial, Special Issue on Intrinsic Hardware Security for Internet of Things Infrastructure, *IEEE INTERNET OF THINGS JOURNAL*, VOL. 6, NO. 1, FEBRUARY 2019.
- [8] Guest Editorial, Special Issue on IoT on the Move: Enabling Technologies and Driving Applications for Internet of Intelligent Vehicles (IoIV), *IEEE INTERNET OF THINGS JOURNAL*, VOL. 6, NO. 1, FEBRUARY 2019.
- [9] M. Ali, R. Dhamotharan, E. Khan, S. U. Khan, A. V. Vasilakos, K. Li, et al., “SeDaSC: Secure Data Sharing in Clouds,” *IEEE Systems J.*, vol. 99, 2015, pp. 1–10.
- [10] S.H. Seo, M. Nabeel, X. Ding, and E. Bertino, “An Efficient Certificateless Encryption for Secure Data Sharing in Public Clouds,” *IEEE Trans. Knowledge and Data Engineering*, vol. 26, no. 9, 2014, pp. 2107–2119.
- [11] L. Xu, X. Wu, and X. Zhang, “CL-PRE: A Certificateless Proxy Re-Encryption Scheme For Secure Data Sharing with Public Cloud,” *Proc. 7th ACM Symposium on Information, Computer and Communications Security*, 2012, pp. 87–88.
- [12] A.N. Khan, M.M. Kiah, S.A. Madani, M. Ali, and S. Shamshirband, “Incremental Proxy ReEncryption Scheme for Mobile Cloud Computing Environment,” *J. Supercomputing*, vol. 68, no. 2, 2014, pp. 624–651.
- [13] Muhammad Baqer Mollah, Cloud-Assisted Internet of Things, 2325-6095/17 © 2017 IEEE.
- [14] Jasmin Guth, A Detailed Analysis of IoT Platform Architectures: Concepts, Similarities, and Differences, *Institute of Architecture of Application Systems*, © 2018 Springer-Verlag.
- [15] Adila Mebrek, Efficient Green Solution for a Balanced Energy Consumption and Delay in the IoT-Fog-Cloud Computing, 978-1-5386-1465-5/17 © 2017 IEEE.

A Novel Steganographic Approach for Embedding Secret Text in Multiple Images with Saw Tooth Pattern

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Abstract— Steganography is the science of sending the data secretly with the use of effective carrier. The ultimate focus of steganography is to hide the secret data from eavesdroppers. At the same time, this approach should keep the carrier medium's quality and it should be hard to hack the information by the eavesdroppers. This paper introduces a novel approach to embed the secret text in multiple image files as frame by frame. Initially the encrypted secret text will be split in to multiple frames as per the number of carrier images. Then each frame is rearranged as per Saw tooth pattern to increase the complexity for the eavesdroppers. The rearranged frames with the prefix of frame number will be embedded in carrier images one by one. As the reverse process, the receiver receives the set of Stego-images and the system will collect all the frames from the stego-images and arrange as per the frame order, then it decrypts using the secret key and produce the secret text.

Keywords— Image Steganography, Digital data Security, LSB, Cryptography, Steganography.

I. INTRODUCTION

In the current digital world, the digital communication is an unavoidable methodology. When one technology grows, parallelly another approach also developed to break or to degrade those technologies by trap or break the security boundaries. A steganographic system is a science of providing the message transfer in the secret way. As this steganographic system is developed, the steg-analysis system also enriched day by day. So we are in the situation to fine-tune the steganographic algorithm to increase the complexity for the steg-analyzer.(Gandharba Swain et al.,2018;Elangovan et al.,2016).

This study introduce the modern approach in steganographic system, that make more anti steg- analysis dimension by hide the secret message in multiple carrier images as frame by frame and each frame is in encrypted form.(M Pavani et al., 2013)In the case of keeping secret data in a single cover media, it provides more possibilities for the steg-analyzer ,if he process for long duration.(SofyaneLadghamChikouche et al., 2017) But whenever there are more cover media for single message communication, it is very difficult to break the security. In addition to that, the Saw-Tooth pattern provides more security for this message communication. In Saw-Tooth pattern, the value may change based on the size of two dimensional array. If the array size is changed during the

extraction process, user can't get the actual data, instead of this, the system may produce the scabbled data which will be in un readable format. So these multiple cover media, Saw-Tooth pattern, size of Saw-Tooth array and cryptography, all four make the system as more efficient and secured steganography.

II. RELATED WORK

Steganography accurately means “covered writing”.The need for the steganography is mentioned by (AnupriyaArya et al.,2018),Information security is a major issue of concern while exchanging a data in an open network, as internet. The data security in the network is becoming more important as the volume of data being exchanged over the Internet increases day by day. The major ultimate techniques for providing the security for the data are cryptography and steganography.In the modern era cryptography and steganography are proposed for hiding secret data from unwanted parties and hackers. The need for modern updated approach for steganography is cleared mentioned by(Gandharba Swain et al., 2018).This work represents that, the simple substitution of secret data in LSB of carrier image is very guileless for the steg-analyzer. This will be the easy process to find the embedded secret message. So it suggests to improve the complexity of steganography algorithm,which makes more complex or not possible for steg-analyzer.

III. PROPOSED WORK

In this proposed work, initially the secret text will be divided into n frames, where n is the number of carrier images. This proposed system supports more than one carrier media for the secret text, so it won't leads to the

problem with the size of secret data. There are two major modules in this system, the first one is Hiding the Secret text and another one is retrieving the secret text.

3.1 Hiding the secret text in Carrier Images

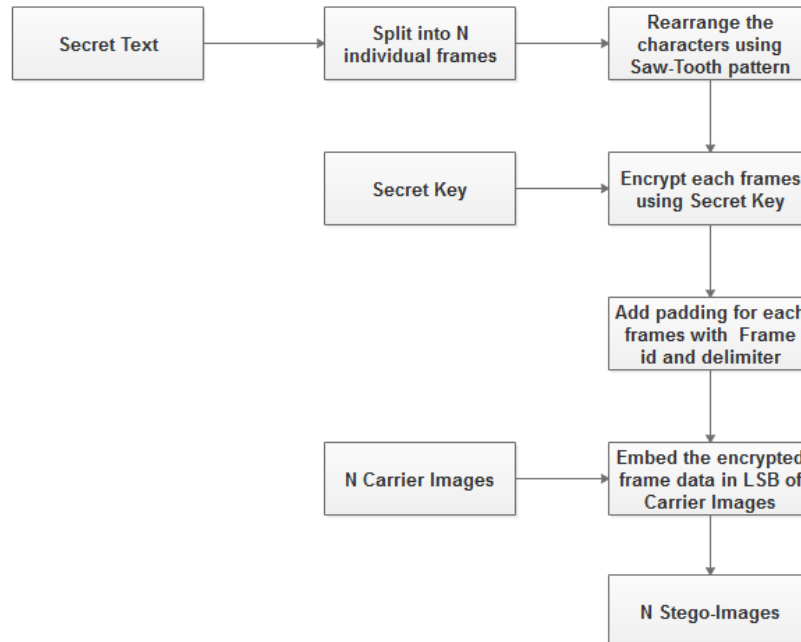


Fig.1: Secret text Hiding in Multiple images

Initially the secret text will be divided to N frames, where N represents the number of carrier images chosen for steganography. Then each N frames of secret text is rearranged with its characters by saw-tooth pattern.

Sample Text: THIS IS THE SECRET MESSAGE

The saw-tooth wave is a type of non-sinusoidal waveform. Since the shape of this pattern matches the teeth of a saw, it named as Saw-Tooth wave. This process can perform using the following formulae.

$$\text{Array value: } n * (\text{Index_Col} - 1) + \text{Index_Row}$$

Where,

T	I	E	R	H	S	S	E	I	T	E	T	S	H	C	M
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Fig.3: A frame with rearranged characters

Then each frame of rearranged secret data will be encrypted using the encryption key, the same key must be needed to decrypt the cipher text.

01	Encrypted Frame	***
02	Encrypted Frame	***
..	Encrypted Frame	***
N-1	Encrypted Frame	***
N	Encrypted Frame	*\$*

Fig.4: List of encrypted frames with padding

n is the size of the 2D array.

Index_Row – Row of the matrix

Index_Col – Column of the matrix

T	H	I	S
I	S	T	H
E	S	E	C
R	E	T	M

Fig.2: Secret text frame filled in Saw-Tooth

The encrypted frames are undergoing the process of padding as in the Figure 4. In this status, front and rear padding for each frames will be added. At front padding, the frame number are added and the rear padding the delimiter are added to specify the end of the frame. For the end frame, a special delimiter will be added to specify the final frame.

Using LSB substitution method, the encrypted data will be embedded in carrier images one by one. This process carried out by embed one frame in one Carrier Image.

After embed all the frames, this process produces the set of N stego-images. In this stage, the stego-images act as the cover media for the secret text.

3.2 Retrieving the secret text

At the receiver end, there are N stego-images. This process will collect all the encrypted frames from the LSB with its frame number. For decryption process, we need to isolate the data part from each frame and then these frames are undergoing the decryption process with the secret key.

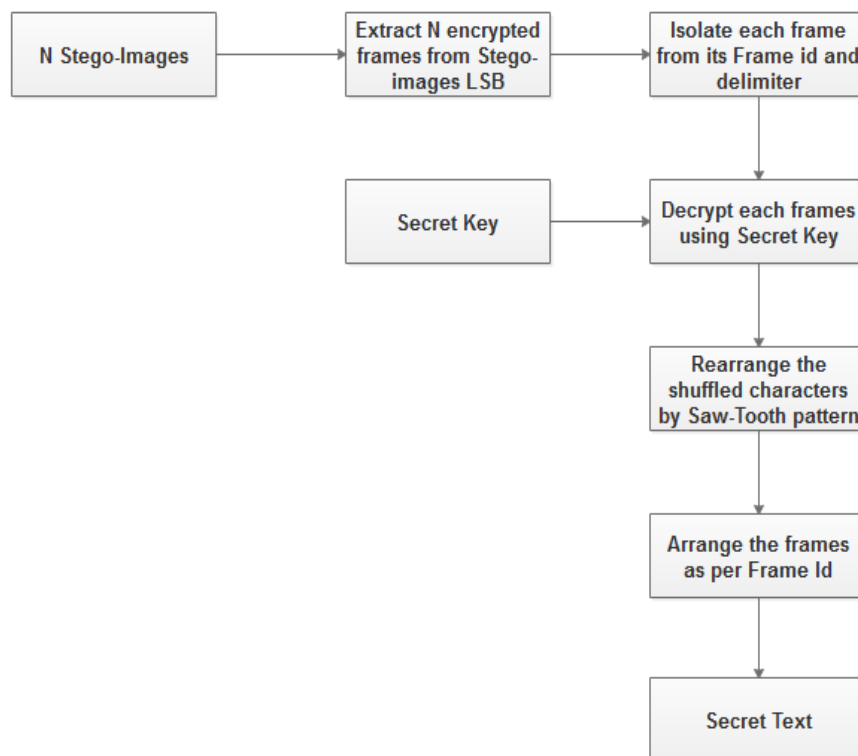


Fig.5: Extraction process of secret text from stego-images.

The decryption of each frame depends on the secret key, which key is used for encryption. If there is a mismatch in key, user can't fetch the exact data. After this successful decryption process, the decrypted frames are rearranged by its character using saw-tooth pattern.

Now using the frame number, the system will arrange all the frames in the sequence and produces the secret text in an efficient manner.

IV. CONCLUSION

This paper introduces the novel approach for secured communication via steganography. The methodology introduced in this paper is to use multiple carrier images as cover media and saw-tooth pattern for shuffle the characters in each frame. It increases the complexity for steg-analyzer and unauthorized parties. In addition to

that, the frames are encrypted and then embed in the carrier media. So it makes more secured communication. Another feature of this approach is that, it produces the stego-images with very less noise ratio, because it uses only one LSB in each pixel byte. Future work can be done by use the video and audio files as cover media which provides more space to hide the image and huge text.

REFERENCES

- [1] Anupriya Arya, Sarita Soni (2018) , A Literature Review on Various Recent Steganography Techniques, International Journal on Future Revolution in Computer Science & Communication Engineering ISSN: 2454-4248, Volume: 4 Issue: 1 143 – 149

- [2] B. Elangovan, B. Srinivasan, P. Rajendiran, T. Birundha, (2016), A multi-pattern based steganographic system for video files to embed secret text with improved decoding complexity, *IJPT* | Sep-2016 | Vol. 8 | Issue No.3 | 17509-17515
- [3] Elangovan. B, Rajesh. K Venkateswari,(2013), An efficient method for high secured image steganography using image segments, *International Journal of Applied Engineering Research*(12),1395-1403.
- [4] Elangovan, B., Srinivasan, B., SenthilSevan, N., Birundha, T. (2015), An efficient audio steganographic system for MP3 format using multi pattern to embed secret text, *Global Journal of Pure and Applied Mathematics*,11 (4), pp. 2477-2486
- [5] Gandharba Swain,(2018) High Capacity Image Steganography Using Modified LSB Substitution and PVD against Pixel Difference Histogram Analysis, *Hindawi Security and Communication Networks*, Volume 2018, Article ID 1505896, 14 pages
- [6] M. Pavani, S. Naganjaneyulu, C. Nagaraju, (2013), "A Survey on LSB Based Steganography Methods", *International Journal of Engineering and Computer Science (IJECS)*, Vol. 2 (8), pp.2464-2467, August, 2013.
- [7] Sofyane Ladgham Chikouche and Nouredine Chikouche,(2017) "An improved approach for lsb-based image steganography using AES algorithm", 5th International Conference on Electrical Engineering - Boumerdes (ICEE-B), IEEE Xplore, 14 December 2017.

Effect of Air Inlet Opening on Air Flow Rate and Drag Force of an Active Indirect Mode Solar Dryer

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Abstract— *The effect of air inlet opening on air flow rate and drag force of an active indirect mode solar dryers was examined. This was done in line with studies which suggested the air flow rate and drag force is affected by the air inlet area of the dryer. The air flow rate of the dryer was obtained as product of the air inlet area and velocity. The shaped of the inlet chosen were: square, rectangular, circular and triangular. The air inlet area was calculated based on the dimension and shape of the inlet. The experimental design adopted (Central Composite Rotatable Design of Response Surface Methodology gave a total of 52 runs for each experiment. The volumetric air flow rate of the dryer increased with increase in air inlet area. The values obtained ranged from 0.0006 to 0.0256 N. The air inlet area of an active indirect mode solar dryer should be increased based on the size of the dryer, to ensure efficient flow of air into the dryer, to fast track drying. The drag force increased with increase in air inlet area. The values obtained ranged from 0.0007 to 0.502 N, as the air inlet area increased across the various shape orientations. The air inlet area of an active indirect mode solar dryer should be increased based on size of the dryer, to enable the blower sufficiently drags air and circulate within the dryer for faster drying of the product.*

Keywords— *air inlet area, air flow rate, blower, drag force, indirect solar dryer.*

I. INTRODUCTION

About 60% of what is harvested locally in Nigeria is lost annually, as a result of poor post-harvest operations (FAO, 2014). Drying as an essential part of post-harvest materials handling, has an important role to play in the safety and durability of agricultural materials. Most rural communities in Nigeria, generally adopt drying, as a means of food preservation, this is largely due to the fact that it adds value of the final product. Drying has been widely regarded as a convenient means of preserving agricultural materials, even beyond the limit which they are expected to be viable. Energy derived from the sun can be utilized for many purposes, ranging from heating, drying, pumping of water and cooking to production of electricity by solar cells. Solar dryers have widely been used in drying of crops, but a major challenge associated with improving its efficiency is that in designing most solar systems, prior attention is not paid to the design of air inlet and outlet vents, which invariably impairs the flow of heated air within the drying chamber. This however results in rewetting of the product

particularly at night. Studies have showed that the air inlet vent of a solar system is largely responsible for flow of air into the system and variation in temperature, which directly has bearing on the amount of free water molecules removed from the cell and surface of product at the initial stage of drying (Alamu *et al.*, 2002; Oguntola *et al.*, 2010). There is need for development of solar drying systems that will analyse and recommend appropriate air inlet spacing and size of the product, to achieve more efficient drying of crops. Such innovation will stimulate interest towards adopting active indirect mode solar drying systems for agricultural products. A survey on most solar active solar dryers constructed for drying of several crops have not taken consideration of the appropriate air inlet size that will guarantee efficient drying of crops at a reduced time. This is a major concern, as dryers that are supposed to be fitted with smaller air inlet size opening, eventually end up being fixed with bigger air inlet and vice versa, since there is no recommended air inlet area for an active indirect mode dryer of any size. Air inlet vent is one of the key

components in constructing a solar drying system. The design of a solar system air inlet vent is dependent on the solar system to be constructed and the type of product to be dried. As reported by Abdulahi *et al.* (2013), increasing the vent area by opening vent, decreases the temperature and increase the air flow within the system. They also held that adequate flow of air into the system is necessary at the early stages of drying, to eliminate free water hovering round the cell of a product as well as the surface. Alamu *et al.* (2002) designed and constructed a domestic passive solar food dryer, and suggested for hot climate passive solar dryers, a gap of 5 cm should be created as inlet air vent. Raju *et al.* (2013) in designing and fabricating an efficient solar drying system, used 7cm as air vent gap and width of 5.6cm, which was slightly higher than what was recommended by the former. Akoy *et al.* (2010) used 70cm as length and 4cm as width of air inlet opening in their design and construction of solar dryer for mango slices. A solar grain dryer with backup heater was designed and evaluated by Tonui *et al.* (2014). They used air inlet spacing of 0.5m with an air flow rate of 227m³/h, to obtain a thermal efficiency of about 58% with average drying rate of 0.0077 kg/h. Bulent-Koc *et al.* (2007) used 20cm as diameter of air inlet and outlet vents respectively in analyzing the effect of air velocity and product size when drying red pepper with solar systems. Papade and Boda (2014) in developing an indirect type solar dryer with energy storing material used an air gap of 49 cm² as inlet vent in their design. Ozumba *et al.* (2013) used 60 cm² as area for air inlet vent when they fabricated a direct absorption solar dryer. Eltawi *et al.* (2012) used 80 cm² as air inlet vent area when they designed a solar wind ventilator to enhance the cabinet dryer performance for medicinal herbs and horticultural products. An adjustable and collapsible solar food dryer was constructed (Abdulahi *et al.*, 2013). An air inlet and outlet vent area of 60 cm² as used, in contrast to 25 cm² recommended and used by Oguntola *et al.* (2010). This according to the study, allowed room for more air flow into the dryer and decreased the temperature and enhancement of removal of free water molecules, which is important at the initial stage of drying. According to Greenheck (2005), blowers are evaluated and selected at variable motor speeds. For direct drive blowers, the speed can be adjusted to meet exact performance requirement by furnishing a speed control medium. Selection charts for various blowers vary depending on the model and what it is to be used for. Manufacturers usually provide information on characteristics performance curves and charts. The required fans must be able to deliver a

suitable static pressure, in order to force the cooling air through the system. A blower is basically selected to provide the required air flow performance within its optimum operating range (Greenheck, 2005). It should also be noted that if a system desires the services of more than one fan, factors such as noise level, spacing, economy and ambient conditions may also be considered in making a final decision on the choice of a blower is made. The most critical aspect of the process of selecting a blower is the ability of the user to read the performance chart which is usually embedded on a catalogue. Typical characteristics of a fan include: break horse power (BHP), Sone and Revolutions per Minute (rpm). Blowers can be classified into the following: axial or propeller fans, centrifugal or radial fans, mixed flow fans and cross flow fans. The classification is basically determined by the nature of which air flows through the medium. In axial flow fans, the air flow is parallel to the shaft and suited for relatively larger volumes to pressure. The different types of axial fans include: propeller fans, vane fans and tube axial fans. Axial fans guarantee high air flow with relatively high pressure build up (Greentech, 2011). Centrifugal fans are type of fans which air flow is in radial direction relative to the shaft. They could be forward curve, backward curve of tabular. Centrifugal fans guarantee high pressure build up at limited flow rate. Tangential fans are useful when high flow rate and low pressure is required. They are basically applicable to large-surface air flow in devices. The air flow through the roller shaped impellers in a dual direction, from the intake area to the outflow area. Bagheri *et al.* (2012) developed an active solar dryer with varying fan speed. The system was simulated and controlled based on changing system variables accordingly to maintain optimum efficiency. In their study, the dryer efficiency was determined by considering the mathematical relationships and monitoring of the air temperature at three positions namely: The inlet and outlet of the collector as well as the outlet vent of the drying chamber. Temple and Van Boxtel (2011) investigated a control system on a laboratory tea fluid-bed dryer. A simulation model was used to combine various factors and system configuration. The model analysed the operating region of the dryer, various disturbances affecting the drying time and couple of other factors. Results obtained showed that the controlled system was significantly better than the manual system which has been in existence for decades. This same feature was adopted by Soheli *et al.* (2006). Bagheri *et al.* (2012) used an axial tube fan of 12 cm in diameter, 200 m³/h flow, 2300

rpm, 38 W, 220 V, 50 Hz alternating current (a.c.) fan to develop an active solar drying system. To effectively optimize the model, the simulated and the real fan speed were compared. It was observed that there was no significant difference between the real and simulated fan speed at probability level of 5 %. A fan with speed of 1700 rpm was used for simulation of the model, though the experiment utilized fan speed ranging from 0-2300 rpm.

II. MATERIALS AND METHODS

The dryer was made up of the solar collector section, the drying chamber and the inlet and outlet vents, solar panels, dry cell battery and blowers. The inlet vent was of various shapes and sizes, while the outlet vent of the dryers was of the same size. The dryer had sawdust as its insulation material at the base and beneath the collector and the drying chamber of known thickness. Glass of 3mm thickness was used as transparent cover material. Plywood was used as construction material. The dryer was inclined at an angle due south and optimum slope angle of 8° from the horizontal plane of the area of study. Each cabinet was fitted with a single layer of crop tray. A blower was attached to the drying chamber to increase air flow rate of hot air within the drying chamber. Nails and screws ranging from tack nails to 5cm long were used as fasteners, to hold various component of the dryer together. Black oil paint was used to paint the dryer. All construction work was done at the Department of Agricultural and Bioresources Engineering, Michael Okpara University of Agriculture, Umudike. The dryers were designed on force convection principle. The outlet vents were uniform (5mm radius). Energy was trapped and stored on a battery, which was used to power the blower. Trapping of the rays was enhanced by the surface of the collector which was painted with black oil paint. The collector aided transfer of heated air through the drying chamber. A door was fixed by the side of the drying chamber for easy loading and off-loading of the drying products. The wall of the drying chamber was covered with a transparent material. The dryers were operated by principles of forced convection, in which air was sucked and blown through the product in the dryer. The dryers had air inlet of various areas and shapes. The area of the collector was obtained as 2m².

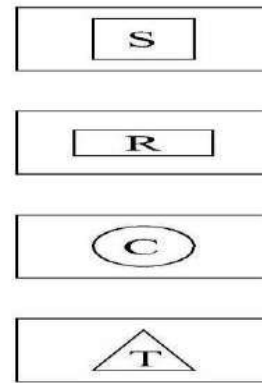


Fig.1: Shapes of the air inlet vent

Legend:

- S – Air Inlet square design
- R – Air inlet rectangular design
- C – Air Inlet design circular
- T – Air inlet design triangular

Based on preliminary studies and size of the dryer a 12volts and 0.3A blower was selected for the dryer. The blower had a dimension of 12 by 12cm and was made of 5 blades. The solar panels available for experiment were three 150 Watts monocrystalline solar panels, which jointly gave a total available output power of 450 Watts.

The volumetric air flow rate of the dryer was computed from equation 1:

$$\text{Air flow rate, } Q = AV \text{ (m}^3\text{/s)} \quad 1$$

Where,

- Q = Volumetric air flow rate
- A = Length x Breadth (m²)
- Velocity of air at the point of inlet, V (m/s)

The drag force of the dryer was computed from equation 2:

$$F_D = \frac{1}{2} \rho V^2 A C_d \text{ (N)} \quad 2$$

- F_D = Drag force (N)
- P = Density of Air (1.225 kg/m³)
- V = Velocity of air at the point of inlet, V (m/s)
- A = Air flow rate, Q = AV (m³/s)
- C_d = Coefficient of drag (Dimensionless)

The experiment was designed to examine the effect of solar collector air inlet shape and product size on the performance of an active indirect mode solar dryer. The two independent variables considered are very important factors affecting the drying using an active direct mode solar dryer. The experimental design adopted was 2 factors, 5 levels, factorial Central Composite Rotatable Design (CCRD) of Response Surface Methodology, as adopted by Taheri-

Garavand *et al.* (2017), while optimizing the drying process of banana.

Central Composite Rotatable Design is comprised of three types of design points namely factorial points (n_f), axial points (n_a) and central points (n_c). According to the Central Composite Rotatable Design, the total number of treatment combinations, was obtained from equation 3.

$$n = 2^k (n_f) + 2k(n_a) + k(n_c) \quad 3$$

where 'k' is the number of independent variables and n is the number of repetition of experiment at the center point. The total number of design points was obtained from equation 4.

$$N = 2^k + 2k + (n_o). \quad 4$$

Therefore, the CCRD involved 13 experiments consisting of 2^2 factorial CCD, with 8 axial points ($\alpha = 2$) and 5 replications at the center points.

For each independent variable, the levels were chosen with respect to moisture content of cooking banana at harvest, preliminary experiments, observations and previous reports by various researchers on various solar dryers since there is no information as regards the optimization of the various drying parameters that influence the drying kinetics using an active direct mode solar dryer for cooking banana. The five levels used for each of the shape inlet are as captured in table 1.

Table 1: Levels of inlet shapes and areas considered for experimental design

S/N	Shape of Inlet	Dimension (cm)	Area (cm ²)
S ₁	Square	2 x 4	4
S ₂	Square	4 x 4	16
S ₃	Square	6 x 6	36
S ₄	Square	8 x 8	64
S ₅	Square	10 x 10	100
R ₁	Rectangular	2 x 4	8
R ₂	Rectangular	4 x 6	24
R ₃	Rectangular	6 x 8	48
R ₄	Rectangular	8 x 10	80
R ₅	Rectangular	10 x 4	40
C ₁	Circular	Radius, R = 1	3.142
C ₂	Circular	Radius, R = 2	12.568
C ₃	Circular	Radius, R = 3	28.278
C ₄	Circular	Radius, R = 4	50.272
C ₅	Circular	Radius, R = 5	78.55
T ₁	Triangular	8 x 2	8
T ₂	Triangular	8 x 4	16
T ₃	Triangular	8 x 6	24
T ₄	Triangular	8 x 8	32
T ₅	Triangular	8 x 10	40



Fig.2: Experimental Site

III. RESULTS AND DISCUSSION

Effect of air inlet area on air flow rate

The air flow rate, which is a key factor as regards optimization of the air inlet opening of the solar dryers were also computed as a function of air velocity and area of the inlet for respective shapes and corresponding dimensions. The values obtained were solely a function of the air inlet

area of the respective dryers. For the square shaped inlet dryers, the air flow rate ranged from 0.00277 to 0.024 m/s³. Dryer with air inlet area of 36 cm² gave an air flow rate of 0.0091 m/s³, while those that were of 100 cm², gave an average air flow rate of 0.024m/s³. Figure 1 represents variation in air flow rate with air inlet dimension and product size for various air inlet shapes.

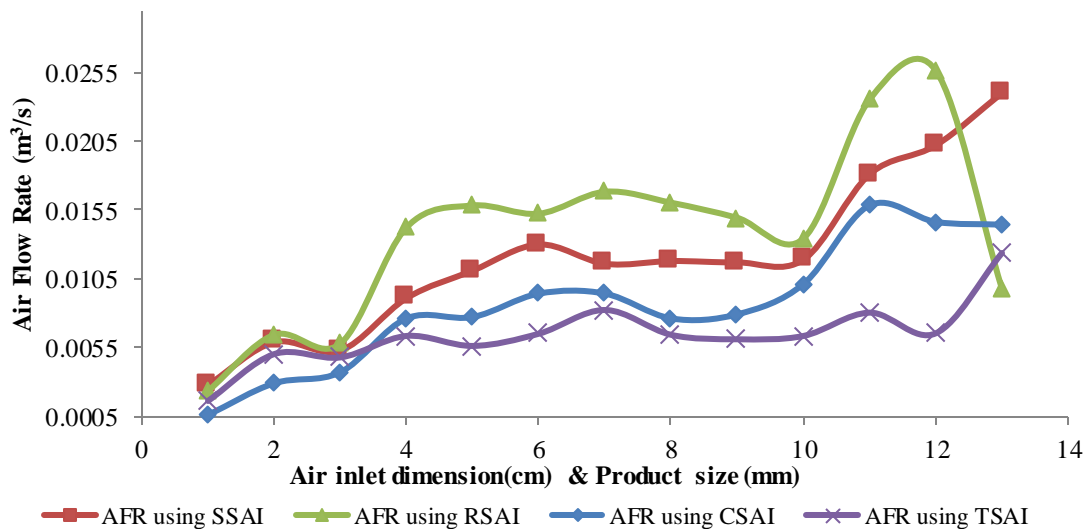


Fig.1: Variation in air flow rate with air inlet dimension and product size for various air inlet shapes

Where AFR is for Air Flow Rate and SSAI, RSAI, CSAI and TSAI represents Square Shape Air Inlet, Rectangular Shape Air Inlet, Circular Shape Air Inlet and Triangular Shape Air Inlet respectively.

The rectangular shaped inlet dryers recorded air flow rate ranging from 0.00232 to 0.0256 m/s³. These values showed increase of 6.25 % from what was obtained in square shaped inlet dryers. It was observed that the air flow rates of

dryers with 48 cm² air inlet area were in close proximity, as against those of lesser air inlet area. The air flow rate of the circular shaped inlet areas was also computed. It was observed that dryers of 28.278 cm² had the same air flow rate (0.0094 m/s³). This was the only similar scenario of the 52 dryers used for the experiment. The values obtained ranged between 0.0006 to 0.0158 m/s³ for the 52 dryers. For the triangular shaped inlet dryers, the air flow rate for dryers ranged between 0.00163 to 0.0123 m/s³. The minimum value was less than what was obtained for square and rectangular shaped inlet dryers, but was about 65 % higher than that of circular shaped inlet dryers. The air flow rate of the respective dryer was dependent on the air velocity and the dimensions of the respective air inlet openings. Dryer of air inlet area 3.142 cm², had the least air flow rate (0.0006 m/s³), the corresponding air inlet area was 12.568 cm². Similarly, dryer of 80 cm² rectangular air inlet area had the highest air flow rate (0.00256 m/s³).

Onyinge *et al.* (2015) obtained a similar high air flow rate while designing and testing an indirect cabinet solar dryer for thin layer drying of *Rastrineobola argental* fish. A volumetric air flow rate of 0.00202m³/s was recorded. This value was in the range of what was obtained from the experiment (0.0006 to 0.0256 m³/s). Hedge *et al.* (2015) also reported high air flow rate in evaluating the performance of a solar dryer for banana. Khaldi *et al.* (2017) also observed that increasing the air inlet area

improved the drying process by reducing fluctuation in temperature and increased air flow by 18%. In the dryers constructed, it was observed that air flow increased at about 98% when comparing dryer with the smallest air inlet area to the highest. Zomorodian and Lamanian (2012) also reported high air flow rates while evaluating an innovative solar air collector with transpired absorber and cover.

Effect of air inlet area on drag force

The drag force was measured with aid of a blower. The blower sucked air from the inlet opening and the air passed through the products, thus enhancing the drying process and increasing the flow of air into the dryer. For the square shaped inlet dryers, the drag force ranged from 0.0008 to 0.0394 N. The values were so closely knitted. The air inlet area of dryers with 36 cm² air inlet area were the same. The rectangular shaped inlet dryers had its drag force range from 0.00412 to 0.0502 N. Figure 2 shows variation in drag force with air inlet dimension and product size for various air inlet shapes. The circular shaped inlet dryers had drag force values quite closer to each other. The least drag force was obtained as 0.000653 N, with an air inlet area of 28.278 cm². The highest drag force of 0.0303 N corresponding to air inlet area of 50.272 cm². The Drag Force computed was hugely dependent on the air inlet area and the air flow rate. Increase in area of inlet and air flow rate lead to corresponding increase in drag force.

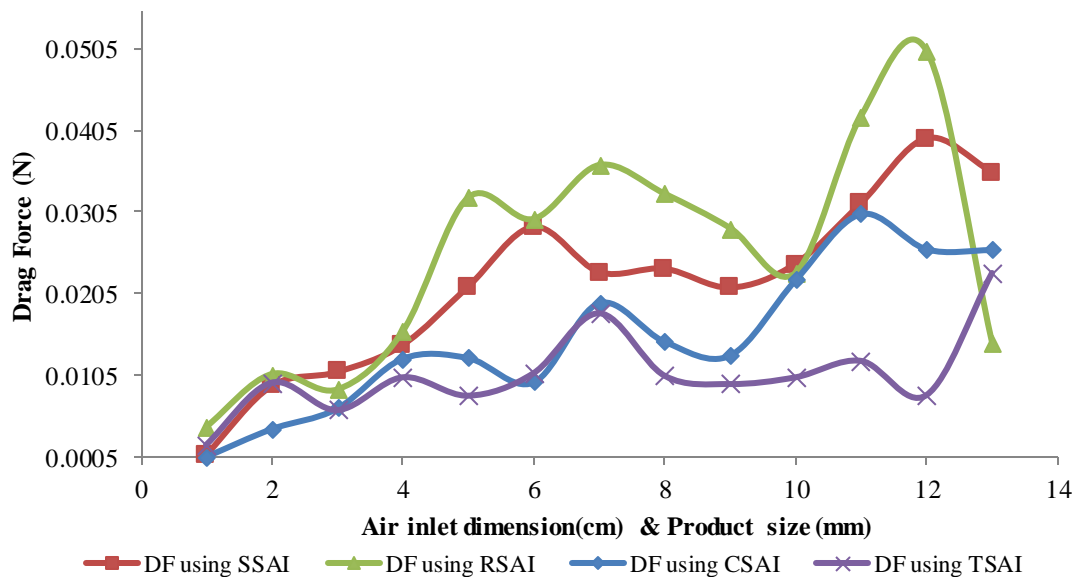


Fig.2: Variation in drag force with air inlet dimension and product size for various air inlet shapes

Where DF is for Drag Force and SSAI, RSAI, CSAI and TSAI represents Square Shape Air Inlet, Rectangular Shape

Air Inlet, Circular Shape Air Inlet and Triangular Shape Air Inlet respectively

For the triangular shaped inlet dryers, the drag force was obtained between 0.0021 to 0.023 N. These values were significantly less than that of square and circular shaped inlet dryers, but somewhat closer to that of the rectangular shaped inlet dryers. Dryers 43 and 49 had the same drag force (0.0103 N). Dryers with inlet area of 24 cm² had the same drag force. The rectangular shaped inlet dryers had the highest drag force, as compared to other. While the least value of drag (0.000653 N) was obtained for dryers with air inlet area of 48 cm², while the highest values of 0.0502 N, was obtained for similar air inlet area.

IV. CONCLUSIONS AND RECOMMENDATIONS

The volumetric air flow rate of the square shaped inlet dryers ranged from 0.00277 to 0.024 m³/s. For the triangular and circular shaped inlet dryers, the air flow rate ranged from 0.00232 to 0.0256 m³/s and 0.000577 to 0.0158 m³/s respectively. The air flow rate of the circular shaped inlet dryer range from 0.00163 to 0.0123 m³/s. The values obtained were a function of the inlet area. The volumetric air flow rate of the dryer increased with increase in air inlet area. The values obtained ranged from 0.0006 to 0.0256 N. The air inlet area of an active indirect mode solar dryer should be increased based on the size of the dryer, to ensure efficient flow of air into the dryer, to fast track drying of cooking banana. The drag force of the square shaped inlet dryers was observed to range between 0.000827 to 0.0394 N, while those of the rectangular shaped inlet dryers ranged from 0.00412 to 0.0502 N. The drag force of the circular and triangular shaped inlet dryers ranged from 0.000653 to 0.0303 N and 0.00206 to 0.023 N respectively. These values were dependent on the area of the inlet and the air flow rate. The drag force increased with increase in air inlet area. The values obtained ranged from 0.0007 to 0.502 N, as the air inlet area increased across the various shape orientations. The air inlet area of an active indirect mode solar dryer should be increased based on size of the dryer, to enable the blower sufficiently drag air and circulate within the dryer for faster drying.

REFERENCES

- [1] Abdullahi, A H. and Ghoneim, A. A. (2013). Thermal Performance of flat plate solar collector equipped with Rectangular Cell Honeycomb. *Destination Renewables*. pp447-456.
- [2] Akoy, E. M., Ismail M. Y., Ahmed E. A. and Luecke, W. (2010). Design and Construction of a solar dryer for mango slices. Institute of Agricultural Engineering, University of Gottingen, Germany.
- [3] Alamu, O. J., Nwakocha C. N. and Adunola, O. (2002). Design and Construction of a domestic passive solar food dryer. *Leonardo Journal of Sciences*. 1(1): pp71-82.
- [4] Bagheri, N. A., Keyhani, A., Mohtasebi, S. S., Javadikia, P. and Abbaszadah R. (2012). Simulation and control of fan speed in a solar dryer for optimization of energy efficiency. *Agric. Eng Int: CIGR Journal*, 14(1). Manuscript No. 1633.
- [5] Bulent Koc, A., Toy, M., Hayoglu, I. and Vardin, H. (2007). Solar drying of red pepper: Effect of air velocity and product size. *Journal of Applied Sciences*. 7(1): pp 1490-1496.
- [6] Eltawi, M. A., Siad, E. A. and El-Hadaad, W. Z. (2012). Solar wind ventilation to enhance the cabinet performance for medicinal herbs and horticultural products. *Agric. Eng. Int'l. CIGR Journal*. 14(4): pp56-74.
- [7] FAO (2014). Drying principles and general considerations. Retrieved from www.fao.org/decrep/t1838eOu.html.
- [8] Greenheck (2005). Introduction to fan selection. Fan fundamentals. Retrieved from www.greenheck.com/media/pdf/qdcatl.
- [9] Greentech (2011). Types of fans and their functions. Development of solar cabinet dryers for dates. *Agricultural Mecahnization in Asia, Arica and Latin America*. 38(2): pp36-44.
- [10] Hedge, V. N., Hosur, V. S. Rathod, S. K., Harsour, P. A. and Narayana, K. B. (2015). Design, Fabrication, and performance evaluation of solar dryer for banana. 5.10.1186/s13705-015-0052-x.
- [11] Khaldi, S., Korti, A, I. N. and Abboudi, S. (2017). Improving the Airflow Distribution Within an Indirect Solar Dryer by Modifications Based on Computational Fluid Dynamics. *International Journal of Air-Conditioning and Refrigeration*. Vol. 25(03), 1750022.
- [12] Oguntola, J. A., Colins, N. N., Olayinka, A. (2010). Design and construction of a domestics passive solar food dryer. *Lenardo Journal of Science*. 16(1): pp23-30.
- [13] Onyinye, G. O., Oduor, A. O. and Othieno, H. E. (2015). The design and testing of an indirect cabinet solar dryer for thin drying of Rastrineobola Argentea fish under the climatic conditions of Maseno, Kenya. *African Journal of Food Science*. 9(1): pp1-16.
- [14] Ozumba, J. O., Okonkwo, N. A., uzor, B. C. and Uba, J. I. (2013). Fabrication and Characterization of a direct absorption solar dryer. *Journals of Advances in Applied Engineering Research*. 4(3): pp186-194.
- [15] Papade, C.V. and Boda, M. N. (2014). Design and development of an indirect type solar dryer with energy storing material. *International Journal of Innovative Research in Advanced Engineering*. 1(2): pp109-114.
- [16] Raju, R.V.S, Really R. M. and Reddy, E. S . (2015). Design and fabrication of efficient solar dryer. *International Journal of Engineering Research and Applications*. 3(6): pp1445-1458.

- [17] Soheli, M. A., Keyhani, A., Abbaspoursani, K. and Akram, A. (2006). Design of a forced convection solar dryer for leafy vegetables and evaluation of the solar energy collector performance. *Journal of Agricultural Engineering and Research*. 7(27): pp147-163.
- [18] Taheri-Garavand, A., Karimi, F., Karimi, M., Lofti, V. and Khoobakht, G. (2017). Hybrid response surface methodology – artificial neural network optimization of drying process of banana slices in a forced convective dryer. *Food Science and Technology International*. 24(4): pp277-291.
- [19] Temple, S. J. and Van Boxel J. B. (2011). Automatic endpoint determination for batch tea dryers. *Journal of Agricultural Engineering and Research*. 78(1): pp51-56.
- [20] Tonui, K. S., Mutai, E. B. K., Mbugu, D. O. and Too, K. V. (2014). Design and evaluation of a solar grain dryer with a backup heater. *Research Journal of Applied Sciences, Engineering and Technology*. 1(1): pp2-8
- [21] Zomorodian, A. and Zamanian, M. (2012). Designing and Evaluation an Innovative Solar air collector with transpired absorber and cover. *International Scholarly Research Notices*. ID 282538.

Fungi with Cellulolytic Potential: Screening, Inoculum, and Methodology for Isolation

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Abstract—The selection of microorganisms with the greatest potential of composer enables to increase efficiency and reduce the time of the composting process. The isolation of fungi has received special attention because they are the main responsible for the degradation of substances of difficult decomposition during the composting process. This review presents a survey of fungi with cellulolytic enzymatic potential, the methods of isolation and screening of these fungi and the methods for determining the potential enzymatic assay. The fungi that decompose rich cellulose residues are the main decomposing agents of ruminal residue, have a diversity of enzymes with degradation capacity of complex organic compounds, such as cellulose, hemicellulose, acids aromatics, and some proteins. Thus, with the indication of fungi that increase the composting efficiency, specific glasses can be developed for the transformation of this type of residue.

Keywords — enzymatic activity, cellulases, cellulose degradation.

I. INTRODUCTION

Organic residues are considered one of the main habitats for the population of microorganisms. Fungi are found in communities ranging from 10^4 the 10^6 microorganisms per gram, actively participating in biodegradation processes, contributing to nutrient cycling and, consequently, to the maintenance of ecosystems [1].

Agroindustry sectors produce a large amount of waste, that, if not availed adequately, represent losses of high value biomass and nutrients, in addition to elevating the final prices of the products. This is due to the treatment, transport and final disposal of residues that directly influences the cost of the process. Nowadays, concepts of recovery, utilization of by-products and bioconversion of waste are increasingly widespread and necessary to ensure the economic viability and biocompatibility of agroindustry chains, as well as reduce

the environmental impact that the accumulation of these wastes causes [2-4].

The large residue availability, such as bovine ruminal, stimulates the search for efficient microorganisms. The transformation of cellulose residues can be performed by cellulolytic fungi, important organisms during the thermophilic phase of the aerobic composting [5]. Composting can be accomplished by the bioconversion of lignocellulosic polymers [6], means of microorganisms and their corresponding enzymes [7, 8]. The process involves the synergistic action of a cellulolytic complex of fungi formed by endoglucanases, exoglucanases, and β -D-glucosidases [9, 10].

Cellulolytic fungi include species of the genera *Trichoderma* e *Aspergillus* [11] as *Trichoderma reesei* E. G. Simmons, *T. koningii* Oudem., *T. lignorum* (Tode) Harz, *Aspergillus niger* Tiegh and others like

Sporotrichum pulverulentum Novobr., *Penicillium funiculosum* Thom, *P. iriensis* Boretti, Garofano, Montec. & Spalla, *Schizophyllum spp.*, *Chaetomium spp.* and *Humicola spp.* [12]. The degradation of residues by the action of fungi can result in different products of high added value such as biofuels, chemicals, enzymes, biofertilizers, among others [13, 14].

The interest in fungi is due to its ability to decompose different substrates, which can generate products or processes, such as the isolation, purification, characterization, and cloning of enzymes capable of degrading compounds consisting of cellulose, hemicellulose, and lignin [15-18].

II. MATERIALS AND METHODS

The methods used for this study were based on the methodology of the article experimental planning factorial: A brief review de DE OLIVEIRA, et al. (2018) [19]. Therefore, this bibliographic review sought to present the fungi species with cellulolytic potential, to demonstrate the forms of isolation, to determine the enzymatic potential and to perform the screening of fungi with this potential.

III. RESULTS AND DISCUSSION

3.1 CELLULOLYTIC FUNGI

Filamentous fungi are usually found in decaying soils and wood [20]. They have been used as a source of production of many metabolites and enzymes, being commercially exploited as "factories" of enzymes. Most commercial cellulases are produced by fungi, mainly those belonging to the genera *Trichoderma* e *Aspergillus* [14].

Cellulolytic fungi, which decompose cellulose substances, occur in the soil and colonize the vegetables, the roots, and their residues, with an important function of nutrient recycling. The fungal activity depends on the organic matter content in the soil, which determines the occurrence and distribution of these organisms [21]. They are the main decomposing agents of the plant material since they possess an enzymatic arsenal with degradation capacity of complex organic compounds, such as cellulose, hemicellulose, aromatic acids, and some proteins.

The fungi have a number of characteristics that make them interesting for application in waste processing systems. They are able to grow under environmental stress conditions, which limit bacterial growth. Moreover, the way of the growth of fungi, induced chemo statically towards the source of organic carbon through the stretching and branching of hyphae, allows the

colonization of large areas [22].

They are considered the most adapted microorganisms for waste transformation because their hyphae can grow on the surface of the particles and penetrate the spaces intraparticle [23]. After the germination of the spores, the fungus hyphae develops in a mycelial tangle, which can be projected, forming air hyphae that penetrate the residue the accumulation of hyphae forms the mycelium, which has the ability to break the cutinized surface of the plant tissue, penetrating the mesophyll, promoting fungal growth [24]. The empty spaces between the air hyphae are often filled by airing, while the empty spaces between the mycelial tangle and particles are filled by water. The metabolic activity occurs mainly near the surface of the substrate and between the pores; however, exposed regions of the mycelium (aerial hyphae) also demonstrate metabolic actions and serve as carriers of substances for the penetrative hyphae [14, 22].

Hydrolytic enzymes are produced by mycelium, diffusing to the solid matrix and catalyze the degradation of macromolecules in smaller units. During this catalysis, oxygen (O₂) is consumed and carbonic gas (CO₂); water (H₂O), Heat and biochemical metabolites are produced. Therefore, gradients develop within biofilms that, for example, force the O₂ to spread to the gaseous phase in deep regions of the biofilm and the CO₂ for gaseous regions [25]. Heat generation causes an increase in temperature to occur rapidly, which is a serious problem during solid state fermentation (FES) and can be removed from the substrate by conduction and evaporation of water. The balance system of the H₂O also includes the H₂O slowly passing through the mycelium. Another important factor is the pH site, which is altered due to the release of carbonic acids and exchange of ammonia [23].

The empty spaces between the air hyphae are often filled by airing, while the empty spaces between the mycelial tangle and particles are filled by water. The metabolic activity occurs mainly near the surface of the substrate and between the pores, however, exposed regions of the mycelium, also show metabolism and serve as carriers of substances for the penetrating hyphae. Hydrolytic enzymes are produced by mycelium, diffuse to the matrix and catalyze the degradation of macromolecules in smaller units. The O₂ is consumed and CO₂, H₂O, heat and biochemical metabolites are produced during cultivation. Therefore, gradients develop within biofilms that, for example, force the O₂ to the gaseous phase in deep regions of the biofilm and the CO₂ differs to gaseous regions [25]. The development of heat causes an increase in temperature to occur rapidly, being a serious problem during FES. Heat is removed from the

substrate via water conduction and evaporation. The balance system of the H₂O also includes the H₂O slowly passing through the mycelium.

Another important factor is the local pH, which is altered due to the release of carbonic acids and ammonia exchange in addition to the secretion of enzymes, which are critical to the decomposition of cellulose, the fungal growth is accomplished by the formation of mycelium and have the ability to break down the cutinized surface of the plant, penetrating the mesophyll [24].

Lignocellulolytic fungi are classified as white degradation and brown degradation. White degradation fungi decompose all wood polymers, including lignin, leaving wood with a white and fibrous aspect [26]. They degrade lignin thanks to the ability conferred by extracellular enzymes such as lignin peroxidase, manganese peroxidase, and laccase, defined as phenol oxidases [24]. Among the white degradation, fungi are *Phanerochaete chrysosporium* Burds, *P. carmosa* (Burt) Parmasto, *Ganoderma lucidum* (Curtis) P. Karst; *Irpex lacteus* (Fr.) Fr., *Pleurotus sapidus* Sacc and other [16, 22]

The fungi of brown degradation, these degrade preferentially the cellulose and cause a rapid decrease in the degree of polymerization [27]. The enzymatic hydrolysis of cellulose in glucose involves the synergistic action of at least three different enzymes: Endoglucanase, exoglucanases, and glycosidase [28]. Endoglucanases randomly cleave the amorphous internal sites of the cellulose polysaccharide chain, originating oligosaccharides of various lengths; Exoglucanases act in the reduction or non-reducing terminals of the cellulose chains, releasing glucose or cellobiose; and glucosidase hydrolyzed cellobiose and glucose soluble oligosaccharides [29]. The synergism between these three types of enzymes makes possible the effective degradation of cellulose [10]. As a result of the initial attack of the brown degradation fungus, causing the depolymerization of cellulose, the rigidity of the wood decays rapidly [30].

The microorganism to be considered ideal for enzymatic production process, according to EL-MANSI et al. (2018) and SAHOO et al. (2019) [25, 3] should present the following characteristics: Be safe from the biological point of view, i.e., not be pathogenic; present high capacity for synthesis and excretion of the enzyme; withstand adverse environmental conditions related to osmotic pressure a temperature be tolerant to the presence of toxic substances, which can be generated in the treatment process of the raw material or by the cellular metabolism itself.

Among the most cited brown degradation fungi in cellulase production are *Aspergillus niger* e *Trichoderma reesei* [18, 31, 32]. Most commercial cellulases are produced by fungi, mainly those belonging to the genera *Trichoderma* e *Aspergillus*.

3.2 TRICHODERMA REESEI E. G. SIMMONS

Many species of this genus are mycoparasites, predominating in the soil microbiology of different ecosystems, such as fields, pastures, forests, and even deserts adapted to survive in various climatic zones. The genre *Trichoderma* it has species capable of producing enzymes and/or attacking and inhibiting other fungi and attracts great attention in several research areas, such as biological control of plant diseases, enzyme production, as well as studies genetic and manipulation in filamentous fungi are usually found in decomposing soils and woods [20]. Many species of this genus are mycoparasites. *Trichoderma* predominates in the soil microbiology of different ecosystems, such as fields, pastures, forests and even deserts adapted to survive in various climatic zones.

Trichoderma reesei is one of the main producers of cellulases, and the microorganism whose cellulases system has been more studied [17, 18]. It produces at least six endoglucanases and two active cellobiohydrolases in different sources of cellulose, crystalline or amorphous [33].

Of the most well studied cellulosic systems, cellobiohydrolases, particularly CBH I, have been considered as essential enzymes for the efficient saccharification of cellulose. Experimental evidence indicates that the removal of the gene encoding for the production CBH I reduces in 70% the activity on crystalline cellulose. In addition, cellobiohydrolases have great synergistic interaction with other cellulases, especially those of known endoglucanase activity [34].

3.3 ASPERGILLUS NIGER TIEGH

The genre *Aspergillus* is highly aerobic and comprises several hundred species found worldwide [35]. Regarding the influence of temperature and water activity, they are able to grow in the temperature range of 6 °C the 47 °C, with an optimum temperature between 35 – 37 °C [36]. *Aspergillus nigeris* a fungus widely used in the production of citric acid and also in the production of enzymes. The ability of these fungi to produce enzymes is related to the ability to use a wide variety of substrates thanks to its well developed enzymatic system [37]. They secrete large amounts of cellulolytic enzymes and, along with the *Trichoderma reesei*, have been extensively studied for the industrial production of these enzymes [37, 38]

3.4 *PENICILLIUM ECHINULATUM* E. DALE

The genre *Penicillium* is among the microorganisms with great potential for the production of cellulases [40]. The mutant strains used in these studies are from the wild lineage called 2HH [41].

The importance of the enzymatic complex of *Penicillium echinulatum* it is also due to the fact that it presents a balanced proportion of activities of FPA (total cell activity) e β -glycosidase, a fact relevant to the hydrolysis of cellulose. Additionally, FPA e β -glycosidases of *P. echinulatum* are important for cellulose hydrolysis because the cellulases produced have thermal stability between 50 °C and 55 °C, respectively [41, 42]

Schneider et al. (2014) [43] studied the effect of six different carbon sources on the morphogenesis and enzymatic production of the lineage S1M29 of *P. echinulatum*. Among these sources, pulp and sugar cane bagasse were the most suitable for FPA, endoglucanases, xygenase, and β -glucosidases. With regard to the growth morphology of *P. echinulatum*, higher enzymatic activities were observed when the mycelium grew in a dispersed form, a possibly explained correlation due to greater interaction between the substrate and hyphae.

3.5 *GANODERMA SPP.*

It is a fungus that is present in natural habitats all over the world. More than 250 species have been reported [44]. Regarding the production of lignocellulolytic enzymes, they found that the proteins produced by the fungus *Ganoderma lucidum* (Curtis) P. Karst with 24% correspond to cellulases and 5% to hemicellulases, in addition to 24% of lignin degradative enzymes, indicating this fungus as a producer of lignocellulolytic enzymes. Others of the same genus are also but in smaller quantities. In addition, they verified that the species produces the complete set of cellulases.

3.6 *CELLULOLYTIC FUNGI AS A SOURCE OF INOCULUM*

The composting process can occur naturally with the involvement of microorganisms present in organic residues. However, insufficient quantity or low biodegradability of the native microbial community may lead to low composting efficiency and undesirable quality of the compound [45]. In order to achieve a reduction in waste transformation time, inoculation is indicated as an efficient technique, as it introduces a population of microorganisms to initiate and accelerate the decomposition process of the organic residue [46]. The inoculum would, therefore, be a way to increase in number and diversity the microbial community of the composting windrows, besides being able to direct to the degradation of a specific residue and/or to ensure more

complete degradation of the components of composting [3, 47].

Inoculation consists of the addition of microorganisms from pure culture, or mass inoculation consisting of a large number of organisms, usually related to the material to which the inoculum will be applied [48]. Composting can be accelerated by the addition of inoculum both in the mesophilic phase and in the thermophilic phase; however, studies have indicated that the inoculation of exogenous and natural microbial populations throughout the whole process is more efficient than the inoculum in just one of the phases [48, 49].

3.7 *FUNGAL ISOLATION WITH CELLULOLYTIC POTENTIAL*

The isolation methodology is proposed by CLARK (1965) [50] with few 112 modifications. Consist of add 10 g of organic compost in 90 ml of saline 113 sterile peptone (0.85% (w/v) sodium chloride and 0.1% (w/v)) of bacteriological peptone [51]. The first dilution is shaken in "Shaker", for 15 minutes 115 to 127 rpm. Subsequently, successive serial dilutions are performed and 100 μ L of sample is spread on the surface of Petri dishes with culture medium. The means used for growth are: Yeast extract peptone glucose (YEPG), composed of (g L⁻¹): Yeast extract, 10; bacteriological peptone, 20; glucose, 20; bacteriological agar, 35.5, plus chloramphenicol antibiotic 0.1% for yeast growth; Nutrient agar (AN) (g L⁻¹): Yeast extract, 3; Bacteriological Peptone, 5; Sodium chloride, 3; Bacteriological Agar, 13, plus nystatin antibiotic (1 ml for 250 ml of culture medium) for bacterial growth; Agar potato dextrose (BDA) (g L⁻¹) prepared according to the medium used for growth is the potato dextrose agar (BDA) (in G L⁻¹) prepared according to the manufacturer plus antibiotic chloramphenicol 0.1% for fungal growth [52]. The inoculated plates are incubated at 28 \pm 2 °C and evaluated daily for up to 5 days. The colonies are separated based on the aspect of the mycelium, spore color and characteristics of the obverse and reverse of the colonies. The colonies are transferred to the plates containing potato dextrose agar culture medium (BDA) for 5 days, 28 \pm 2 °C. These colonies were reinoculated in selection medium until pure crops were obtained. Pure fungi colonies were preserved following the Castellani method [53].

The bacteria are purified by the technique of exhaustion to obtain isolated colonies. This technique consists of making stretch marks, with the aid of a platinum strap, in a solid medium, where, by exhaustion, isolated colonies are obtained at the end of the stretch

marks. As for the purification of the fungi, after the colonies appear, they are separated based on the aspect of the mycelium, spore color and other characteristics of the obverse and reverse of the colonies. These colonies are reinoculated, through stretch marks, in selection medium until the attainment of pure crops [54]. After the incubation period, the total count of the morphotypes found is performed and characterized according to their morphology, including size, shape, color, edge, appearance, brightness and elevation according to the methodology of YARROW, (2008) [55]. Pure fungi colonies are preserved following the Castellani method [53]. All tubes/plates are stored in a refrigerator, the temperature of approximately 4 °C.

3.8 SCREENING OF CELLULOLYTIC FUNGI

The isolated fungi are evaluated for their cellulolytic activities in plaques containing agar and Vogel salts [56], containing (g L⁻¹): Na₃C₆H₅O₇.5H₂O, 150; KH₂PO₄, 250; NH₄NO₃, 100; MgSO₄.7H₂O, 10; CaCl₂.2H₂O, 5, biotin solution (0,1 mg ml⁻¹) 5; Chloroform 0.2 ml, solution of trace elements (g L⁻¹), 5 ml [C₆H₈O₇.H₂O, 50; ZnSO₄.7H₂O, 50; Fe(NH₄)₂(SO₄)₂.6H₂O, 10; CuSO₄.5H₂O, 2.5; MnSO₄.H₂O, 0.05; H₃BO₃, 0.05; Na₂MoO₄.2H₂O, 0.05], diluted 50 times in distilled water, supplemented with 0.2% of yeast extract, supplemented with 1% (m/v) of the carbon source, with carboxymethylcellulose (CMC), and 1.5% (m/v) agar. The isolates are previously activated in BDA medium [agar potato dextrose (in g L⁻¹) 42 g] plus chloramphenicol antibiotic 0.1% and inoculated in the center of the petri dish incubated at a temperature of 30 °C.

3.9 EVALUATION OF CELLULOLYTIC ACTIVITY

The revelation for the determination of cellulolytic activity is performed by the addition of the solution of Congo red 0.25% (m/v) in Tris-HCl buffer 0.1 M pH 8.0, according to the method proposed by HANKIN and ANAGNOSTAKIS, (1975) [57]. The washing of the middle surface is conducted with a 1M NaCl solution in the same buffer and observed transparent halo in contrast to opaque medium.

3.10 CALCULATION OF THE ENZYMATIC INDEX

The crops in which it is possible to observe the formation of halo around the colony has its activity evaluated through the enzymatic index (IE), that is, the diameter of the halo divided by the diameter of the colony [58].

3.11 DETERMINATION OF ENZYMATIC POTENTIAL

The industrial cultivation of fungi with the purpose

of obtaining enzymes, resulting from its metabolism, is biotechnological activity in wide expansion. The two main strategies for determining the potential of enzymes are the processes of submerged fermentation and solid state fermentation [59].

Submerged fermentation is the technique mostly used in industrial processes due to the ease of growth of fungi in controlled conditions of pH and temperature, in addition to making it easy to recover the enzymes extracellular [18]. This process uses fermentative medium, where the sources of nutrients used are soluble and the development of the microorganism occurs in the presence of free water. The water content in this process is greater than 95% [60]. It is a system capable of generating a variety of metabolites in which filamentous fungi are of great importance [61]. In relation to solid state fermentation, submerged cultivation has as its advantage the possibility of having better rationalization and standardization of the process, which is fundamental for the industry [23] in addition to allowing a homogeneous culture system [62].

Regarding solid state fermentation (FES), the culture medium is composed of solid substrates, acting as a carbon source, without free water, which makes this condition of growth try to approach the natural habitat. It is an alternative cultivation system for the production of value added products from fungi, especially enzymes [63]. Products or by-products from agroindustry, in the form of raw waste, are employed in FES as substrates to serve as solid matrix and provide carbon for the growth of the fungus, in addition to presenting low cost [60]. FES is suitable for filamentous fungi, as these can develop in environments that have low levels of relative humidity. In addition, filamentous fungi have favorable air hyphae for the colonization of solid substrates [65].

Second Paranthaman et al. (2008) [63] FES has advantages over submerged fermentation, such as lower energy requirements, lower reactor volume, and high productivity, low capital investment, low waste of water, a higher concentration of metabolites obtained and lower processing cost. However, FES also has some limitations, such as the difficulty of heat dissipation generated by microbial metabolism, limited oxygen transfer depends on substrate granulometry; difficulty in temperature control and beyond these variables, there is a greater difficulty in collecting representative samples during the process, due to the non-homogeneity of the mass in fermentation [63].

3.12 EVALUATION OF ENZYMATIC ACTIVITY IN SUBMERGED FERMENTATION

The submerged fermentation is prepared in

Erlenmeyer vials of 125 mL, containing 30 mL of Vogel's liquid medium [56], supplemented with 1% of the carbon source (e.g.: Wheat bran) and sterilized at 121 °C for 15 minutes for the production of FPase enzymes, endoglucanase, exoglycanase, and xylanase. The crops are inoculated with 1 mL of a suspension of 10^7 spores mL⁻¹ and are kept for 5 days at 100 rpm, 30 °C. Fermented broths are filtered in an ice bath and frozen for evaluation of enzymatic activity [66].

3.13 EVALUATION OF ENZYMATIC ACTIVITY BY SOLID STATE FERMENTATION

The fermentation on solid substrates can be carried out in polypropylene or Erlenmeyer plastic bags containing the raw material plus distilled water and then autoclaved to 121 °C during 20 minutes. The inoculation of the substrate is performed with 1 mL of spore suspension standardized at 10^6 spores mL⁻¹, properly homogenized. In mixed crops, inoculation is performed with 1 mL of spore suspension standardized at 10^6 spores mL⁻¹ for each fungus used. The crops are kept at 30 °C for 5 days.

The extraction of the enzymes can be accomplished by adding 100 mL of chilled distilled water to the fermented medium to which, subsequently, it is subjected to orbital agitation at 8000 rpm, for 20 minutes. The medium is then filtered by vacuum, an ice bath and the extract wrapped in test tubes in the freezer subsequently used to evaluate the enzymatic activity [66].

3.14 TOTAL CELLULASES ACTIVITY (FPASE)

The activity of total cellulases (FPase) is determined according to the recommendations of the IUPAC [52] using filter paper (Whatmann N°1) measuring 1.0 x 6.0 cm, equivalent to 50 mg, as substrate [67]. The reaction medium consists of a mixture of sodium citrate buffer 0.05 M pH 4.8 and a strip of filter paper. The reaction is initiated with the addition of the enzyme extract, remaining for 60 minutes and 50 °C. The reaction is interrupted by the addition of 3 mL of DNS and maintained at 100°C for 5 minutes. After cooling the samples are added 20 mL of distilled water. The readings are performed in a spectrophotometer at 540 nm. The release of reducing sugars is determined according to MILLER (1959) [68], using glucose as standard, from the method of dinitrosalicylic acid (DNS). An enzyme activity unit is defined as the amount of enzyme required to release 1 mmol glucose per minute per mL [9].

3.15 ENDOGLUCANASE ACTIVITY, EXOGLYCANASE, AND XYLANASE

The activities of endoglucanase, exoglucanase, and xylanase are determined using 1% carboxymethylcellulose solution (CMC), Avicel®

(microcrystalline cellulose) and xylina, respectively, in sodium acetate buffer 0.05 M, pH 5.5. The reactional medium consists of 400 mL of the substrate and 400 µL of the enzyme extract, kept at 60 °C. After time intervals 0 (control), 5 and 10 minutes, aliquots of 200 µL are removed from the reaction medium and the response interrupted by the addition of 200 µL of DNS and boiled for 5 minutes. The samples are cooled, and 2 mL of distilled water is added. The readings are performed in a spectrophotometer at 540 nm. The release of reducing sugars is determined according to the MILLER (1959) [68], using glucose or xylose as standard (molar extinction coefficient (ϵ) glucose 80.54 m⁻¹ cm⁻¹ or xylose 74.27 m⁻¹ cm⁻¹), from the acid method dinitrosalicylic acid (DNS). An enzyme unit is defined with the amount of enzyme required to release 1 µmol of glucose or xylose per minute per milliliter [69].

3.16 CELLULOLYTIC MICROORGANISMS AS A SOURCE OF INOCULUM

The composting process can occur naturally with the involvement of microorganisms present in organic residues. However, insufficient quantity or low biodegradability of the native microbial community may lead to low composting efficiency and undesirable quality of the compound [45]. In order to achieve a reduction in waste transformation time, inoculation is indicated as an efficient technique, as it introduces a population of microorganisms to initiate and accelerate the decomposition process of the organic residue [46]. The inoculum would, therefore, be a way to increase in number and diversity the microbial community of the composting windrows, besides being able to direct to the degradation of a specific residue and/or to ensure more complete degradation of the components of composting [47].

Inoculation consists of the addition of microorganisms from pure culture, or mass inoculation consisting of a large number of organisms, usually related to the material to which the inoculum will be applied [48]. Composting can be accelerated by the addition of inoculum both in the mesophilic phase and in the thermophilic phase, however, studies have indicated that the inoculation of exogenous and natural microbial populations throughout the whole process is more efficient than the inoculum in only one of the phases [48, 49].

IV. CONCLUSION

Fungi with cellulolytic potential are important in the process of transforming agricultural residues in products of higher added value, such as organic compost, enzymes and developing glasses.

REFERENCES

- [1] SELLE G L. Ciclagem de nutrientes em ecossistemas florestais. Bioscience journal; (2007).
- [2] CECI A. (2019) 1. Roles of saprotrophic fungi in biodegradation or transformation of organic and inorganic pollutants in co-contaminated sites. Applied Microbiology and Biotechnology. 103(1):53-68.
- [3] SAHOO K, GAUR M, SUBUDHI E. Cellulolytic thermophilic microorganisms in white biotechnology: a review. Folia Microbiologica; (2019).
- [4] WANG H, GURAU G, ROGERS RD. Ionic liquid processing of cellulose. Chemical society reviews; (2012).
- [5] ROY BC, KHAN MRL, SALLEH MAM, AHSAN A, AMIN, MR. Development of a convenient method of rumen content composting. Journal of animal and veterinary advances; (2013).
- [6] BIAŁOBRZEWSKI I. (2015). Model of the sewage sludge-straw composting process integrating different heat generation capacities of mesophilic and thermophilic microorganisms. Waste management. v. 43:1–12.
- [7] KHOKHAR I. (2012). Isolation and screening of highly cellulolytic filamentous fungi. Journal of applied sciences and environmental management. 16(3):223–226.
- [8] KUHAD RC, GUPTA R, SINGH A. Microbial cellulases and their industrial applications; (2011).
- [9] RAY RC, ROSSEL CM; (2017). Microbial Enzyme Technology in Food Applications. Raton: CRC Press.
- [10] VRIES R, VISSER J. Enzymes involved in degradation of plant cell wall polysaccharides. American society for microbiology; (2001).
- [11] CHUNDAWAT SPS. (2011). Proteomics based compositional analysis of complex cellulase hemicellulase mixtures. Journal of proteome research. 10(10):4365–4372.
- [12] SILVA R, YIM DK, PARK YK. Application of thermostable xylanases from Humicola sp. for pulp improvement. Journal of fermentation and bioengineering; (1994).
- [13] ANWAR Z, GULFRAZ M, IRSHAD M. (2014). Agro-industrial lignocellulosic biomass a key to unlock the future bioenergy: A brief review. Journal of radiation research and applied sciences. 7(2):163–173.
- [14] SELIM K. (2018) 3. Bioethanol a microbial biofuel metabolite; new insights of yeasts metabolic engineering. Fermentation. 4(1):16.
- [15] AMORE A. Industrial waste based compost as a source of novel cellulolytic strains and enzymes. FEMS microbiology letters; (2012).
- [16] BRIGHAM JS, ADNEY WS, HIMMEL ME. (2018). Hemicellulases: Diversity and Applications. Handbook on Bioethanol. 1:119–141.
- [17] HIMMEL ME. (2018). Cellulases: Structure, Function, and Applications. Handbook on Bioethanol. 1:143–161.
- [18] JAYASEKARA S, RATNAYAKE R. Microbial Cellulases: An overview and applications; (2019).
- [19] OLIVEIRA M. DE. (2018). Experimental Planning Factorial: A brief. Review International Journal of Advanced Engineering Research and Science. 6495(6):166–177.
- [20] SAMUELS GJ. (1996). Trichoderma: A review of biology and systematics of the genus. Mycological research. 100(8):923–935.
- [21] RUEGGER MJS, TAUKE-TORNISIELO SM. Atividade da celulase de fungos isolados do solo da estação ecológica de Juréia-Itatins, São Paulo, Brasil. Brasil botânica; (2004).
- [22] DIX NJ, WEBSTER J; (1995). Fungal Ecology. Springer Science & Business Media.
- [23] HÖLKER U, LENZ J. Solid-state fermentation - Are there any biotechnological advantages? Current opinion in microbiology; (2005).
- [24] LEE H. Biotechnological procedures to select white rot fungi for the degradation of PAHs. Journal of microbiological methods; (2014).
- [25] EL-MANSI EMT; (2018). Fermentation microbiology and biotechnology. Raton: CRC Press.
- [26] GONZÁLEZ GEM. (2016). Use of native Basidiomycetes in the biotransformation of buffel grass (Cenchrus ciliaris) to improve the nutritional quality. Revista Mexicana de micología. v. 43:31–35.
- [27] MONRROY M. Structural change in wood by brown rot fungi and effect on enzymatic hydrolysis. Enzyme and microbial technology; (2011).
- [28] LI L. Hydrothermal carbonization of food waste and associated packaging materials for energy source generation. Waste management; (2013).
- [29] NURKANTO A. Cellulolytic activities of actinomycetes isolated from soil rhizosphere of waigeo, raja ampat, west papua. Journal tanah tropika; (2009).
- [30] MONRROY M. Bioorganosolv pretreatments of P. radiata by a brown rot fungus (Gloeophyllum trabeum) and ethanolysis. Enzyme and microbial technology; (2010).
- [31] RABINOVICH ML, MELNICK MS, BOLOBOVA AV. (2002). The structure and mechanism of action of cellulolytic enzymes. Biochemistry (Moscow). 67(8):850–871.
- [32] SAHA BC. Production, purification and properties of endoglucanase from a newly isolated strain of mucor circinelloides. Process Biochemistry; (2004).
- [33] KARLSSON J. (2002). Enzymatic properties of the low molecular mass endoglucanases Cel12A (EG III) and Cel45A (EGV) of Trichoderma reesei. Journal of biotechnology. 99(1):63–78.
- [34] BELDMAN G. Synergism in cellulose hydrolysis by endoglucanases and exoglucanases purified from Trichoderma viride. Biotechnology and bioengineering; (1988).
- [35] GUPTA M, MANISHA K, RUBY G. (2012). Effect of various media types on the rate of growth of Aspergillus niger. Indian journal of fundamental and applied life sciences. 2(2):141–144.
- [36] SCHUSTER E. (2002). On the safety of Aspergillus niger - A review Applied microbiology and biotechnology. 59:4–5.

- [37] SHAHLAEI M, POURHOSSEIN A. Biomass of *Aspergillus Niger*: uses and applications. Journal of reports in pharmaceutical sciences; (2013).
- [38] SALIU BK, SANI A. (2012). Bioethanol potentials of corn cob hydrolysed using cellulases of *Aspergillus niger* and *Penicillium decumbens*. EXCLI Journal, v. 11:468–479.
- [39] CHEN Y. N. N-dimethylformamide induces cellulase production in the filamentous fungus *Trichoderma reesei*. Biotechnology for Biofuels; (2019).
- [40] DILLON AJP. (2011). A new *Penicillium echinulatum* strain with faster cellulase secretion obtained using hydrogen peroxide mutagenesis and screening with 2-deoxyglucose. Journal of applied microbiology. 111(1):48–53.
- [41] SCHNEIDER WDH. (2016). *Penicillium echinulatum* secretome analysis reveals the fungi potential for degradation of lignocellulosic biomass. Biotechnology for Biofuels, v. 9. 1:66.
- [42] MARTINS LF. (2008). Comparison of *Penicillium echinulatum* and *Trichoderma reesei* cellulases in relation to their activity against various cellulosic substrates. Bioresource Technology. 99(5):1417–1424.
- [43] SCHNEIDER WDH. (2014). Morphogenesis and production of enzymes by *Penicillium echinulatum* in response to different carbon sources. BioMed research international, n. 254863:1–10.
- [44] ZHOU LW. (2015) 6. Global diversity of the *Ganoderma lucidum* complex (Ganodermataceae, Polyporales) inferred from morphology and multilocus phylogeny. Phytochemistry. 114:7–15.
- [45] XI BD. A temperature-guided three-stage inoculation method for municipal solid wastes composting. Environmental engineering science; (2007).
- [46] KIEHL EJ. Manual de compostagem: maturação e qualidade do composto. ; (2002).
- [47] GHAFFARI S. (2011). Effectiveness of inoculation with isolated *Anoxybacillus* sp. MGA110 on municipal solid waste composting process. African journal of microbiology research. 5(30):5373–5378.
- [48] XI B. (2012). Chemosphere effect of inoculation methods on the composting efficiency of municipal solid wastes. Chemosphere. 88:744–750.
- [49] WEI Z. (2007). Effect of inoculating microbes in municipal solid waste composting on characteristics of humic acid. Chemosphere. 68(2):368–374.
- [50] CLARK FE. Agar-plate method for the total microbial count. Methods of soil analysis, Part 2. Chemical and microbiological properties; (1965).
- [51] DA SILVA N, JUNQUEIRA VCA, SILVEIRA NFA; (2001). Manual de métodos de análise microbiológica de alimentos. São Paulo: Livraria Varela.
- [52] BISCHOF RH, RAMONI J, SEIBOTH B. (2016). Cellulases and beyond: the first 70 years of the enzyme producer *Trichoderma reesei*. Microbial Cell Factories. 15(1):106.
- [53] CASTELLANI A. (1967). Maintenance, and cultivation of common pathogenic fungi of man in sterile distilled water. Further researches. Journal of Tropical Medicine and Hygiene. 70:181–184.
- [54] TORTORA GJ, FUNKE BR, CASE CL; (2012). Sao Paulo: Artmed Editora.
- [55] YARROW D. Methods for the isolation, maintenance, and identification of yeasts.; (2008).
- [56] VOGEL HJ. (1956). Convenient growth medium for *Neurospora crassa* (medium N). Microbiology Genetics Bulletin, v. 13:42–43.
- [57] HANKIN L, ANAGNOSTAKIS SL. The Use of Solid Media for Detection of Enzyme Production by Fungi. Mycologia society of America; (1975).
- [58] HANKIN L, ANAGNOSTAKIS SL. (1977). Solid media containing carboxymethylcellulose to detect Cx cellulase activity of micro-organisms. Journal of general microbiology. 98(1):109–115.
- [59] CASTRO AMD, JUNIOR NP. Produção, propriedades e aplicação de cellulases na hidrólise de resíduos agroindustriais. Química nova; (2010).
- [60] ORLANDELLI RC. Enzimas de interesse industrial: produção por fungos e aplicações. Revista saúde e biologia; (2012).
- [61] GIBBS PA, SEVIOUR RJ, SCHMID F. Growth of filamentous fungi in submerged culture: Problems and possible solutions. Critical reviews in biotechnology; (2000).
- [62] AGUILAR CN. Differences in fungal enzyme productivity in submerged and solid-state cultures. Food science and biotechnology; (2004).
- [63] PARANTHAMANR. (2008). Optimisation of fermentation conditions for the production of tannase enzyme by *Aspergillus oryzae* using sugarcane bagasse and rice straw. Global journal of biotechnology. v. 3(2):105–110.
- [64] SUBRAMANIAM R, VIMALA R. (2012). Solid state and submerged fermentation for the production of bioactive substances: A comparative study. International journal of science and nature. International journal of science and nature. 3(3):480–486.
- [65] SANTOS DT. Potencialidades e aplicações da fermentação semi-sólida em biotecnologia; (2006). Nota técnica.
- [66] BENTIL JA. (2018). Cellulase production by white-rot basidiomycetous fungi: solid-state versus submerged cultivation. Applied Microbiology and Biotechnology. 102(14):5827–5839.
- [67] GHOSE TK. (1987). Measurement of cellulase activities. International union of pure and applied chemistry. International union of pure and applied chemistry. 59(4):257–268.
- [68] MILLER GL. (1959). Use of dinitrosalicylic acid reagent for determination of reducing sugar. Analytical chemistry. 31(3):426–428.
- [69] LIN CC, YAN CJS, KAN SC, HSUEH, NC. (2017). Deciphering characteristics of the designer cellulosome from *Bacillus subtilis* WB800N via enzymatic analysis. Biochemical Engineering Journal, v. 117:147–155.

Situated Learning of Management Competencies in the Practice of a Community

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Abstract— *Aiming to understand how the situated learning of managerial competencies, which occurs in the social practice of a student community, contributes to the schooling of those who participate in it, this article presents the results of a qualitative research. The research was done through participant observation, backed up in a field diary, interviews and photographs. The results revealed that, in the process of situated learning of managerial competencies that takes place in practice of community, the interweaving of "knowing" to "doing" ensues, contributing to fill the theoretical and epistemological gap existing between the two concepts. Thus, this work contributes to theoretical elaborations on managerial learning in social practice and creates perspectives for investigations about how the student communities complement the schooling of students who participate in them.*

Keywords— *Do, Situated learning, Social practice, To know.*

I. INTRODUCTION

The importance of learning, in the context of teaching and research in Administration, inspired the proposal of this study, whose theme is the situated learning of managerial competencies in the social practice of a student community. The interest in this theme stems from the search for ways to improve the professional schooling of students in the functional disciplines of Administration, as in the case of the Production Management discipline, for example. Production management is, above all, a practical matter, dealing with real problems. In this discipline, productivity appears as a key issue to be clarified, as early as its introduction. Productivity is a basic measure of performance being measured in the production by the value of the results obtained (products) in relation to the costs, that is, in relation to the value of the inputs used (Krajewski, Ritzman, & Malhotra, 2009). To that extent, labor costs (wages) are of major importance, referring to a specific measure: labor productivity - a measure of production per person or hour worked. A requirement then placed on companies is to increase the value of the result in relation to the cost of labor. In this process, aiming optimize people's performance. The productivity challenge raises questions about the learning processes that underpin professional training.

Several authors affirm that the development of competences needs to be based on learning cultures, be they developed in the educational environment, or in the professional scope (Le Boterf, 2003; Antonello C. S.,

2007; Zarifian, 2012; Abbad, 2013; Dias Junior, Moreira, Stosick, & Pereira, 2014). For this, it is recommended that educational tasks be not centered on teaching, but on learning practices (Fleury & Fleury, 2001; Antonello & Ruas, 2005; Dias, Becker, Dutra, Ruas, & Ghedine, 2013). This positioning is typical of the literature that emphasizes systemic and integrated perspectives for managerial learning. Such perspectives advocate policies and approaches that locate managerial schooling within its broad technical, social, political, and cultural context in business-related learning models, since they have the potential to assist Education as they contribute to the development of competencies for a future professional career (Antonello & Ruas, 2005; Clyde, 2015).

Practice, in turn, has been considered particularly relevant in the context of research and teaching. Regarding research, the need for studies that address learning practices is explored, exploring how they emerge in the process of human interaction and action (Antonacopoulou & Chiva, 2007). As far as teaching is concerned, the potentialities that the practice brings to traditional didactic approaches, which privilege the transmission of formal and conceptual knowledge of the various functional disciplines, are exalted. These approaches highlight, in our Western culture, the epistemological and institutional gap that separates the typical cognitive situation from action, from conceptual and analytical knowledge (Koike & Mattos, 2000). Such separation produces a break between "knowing" and "doing", obscuring the dynamics of the production of

knowledge and its effects, producing an inertia based on knowing much and doing little, that is, on a gap between the "Knowing" and "doing" (Pfeffer & Sutton, 2001).

The focus on the interweaving between 'knowing' and 'doing' directed this study to the fact that in the so-called professional areas, such as Administration, Medicine and Engineering, scientific knowledge only makes sense when applied to practice, and different knowledges that contribute to professional development (Schommer, 2005). In these areas, practice, experience, action, rather than speculation, are essential in the production of knowledge. Theories, ideas and hypotheses are instruments that impel action, and these are true when they are useful and can be verified. The characteristic of the "professions" show that the "knowledge" produced in it requires usefulness, applicability. It is, therefore, a prescriptive "knowing" of what must be done, of how it should be done, of who has competence to do, and so on (Cavedon, 2014).

This result-oriented view, which is geared to doing things and finding solutions to problems, regardless of ideological and political differences, as well as understanding the meanings of phenomena in terms of their consequences, is characteristic of pragmatism. For this school of thought, ideas are only important if they serve as an instrument for solving real problems. John Dewey asserted that even philosophy should have practical utility in people's lives, helping them to intelligently solve everyday problems. For Dewey, the learning experience is reflexive, not just reproductive, resulting in new knowledge. To do so, the following aspects are essential: the learner must participate in true experimentation situations; the activity should be of interest to you; there must be a problem to be solved; he must possess the knowledge necessary to act in the face of the situation; he should have the chance to test his ideas. It is understood, therefore, that reflection and action are interconnected, being part of an indivisible whole (Elkjaer, 2013; Farjoun, Ansell & Boin, 2015).

Thus, to bridge the gap between "knowing" and "doing", another mode of learning that goes beyond formal classroom learning has been recommended. This other way includes experiencing real situations in the business world, in which the practice of student communities represent alternative forms of learning in action. Thus, arguing that the learning that occurs in the social practice of a student community promotes the interweaving of "knowing" to "doing", we ask in this article: how the situated learning of managerial competences that occurs in the social practice of a student

community, contributes to the schooling of those who participate in it?

To answer this question a qualitative research was carried out in an Engineering Competition Team, where its practice was observed and people involved were interviewed. The result of this research demonstrated that the learning of managerial competences, which occurs in the practice of the team, transposes the limits of the formal learning of the classroom and is situated in a conjuncture of real situations of the business world. This process thus makes an important contribution to the academic schooling of the students who participate in it.

The presentation of the research results is organized into five sections, including this introduction. The second section shows how learning studies can benefit from a focus on social practices. In the third section, the research methodology is detailed, followed, in the fourth, of the research findings. The fifth section concludes with a discussion of the contributions to theoretical elaborations on learning and social practices and how such elaboration facilitates the filling of the epistemological and institutional gap between "knowing" and "doing."

II. THEORETICAL REFERENCE

The combination of theoretical content with real professional practice contexts seems to result in environments that are conducive to effective learning (Antonello & Ruas, 2005). According to Deiglmeier (2013), when students put the "hand in the mass", they understand that they will have to deal with successes and failures which act in favor of building their skills and consequent professional schooling.

Thus, the potential that the practice brings to the traditional didactic approaches, which privilege the transmission of formal and conceptual knowledge of the various functional disciplines of the Administration, is exalted. There is no denying that teaching strategies such as case studies, games and simulations are examples of didactic approaches that bring good educational results, since, by systematically articulating theory and practice, they construct rich opportunities for knowledge production. However, these approaches present deficiencies because they can not replace the everyday reality of managerial procedures (Antonello & Ruas, 2005). In addition, the isolation of the market, which characterizes Brazilian education, has been identified as one of those responsible for the very theoretical and impractical schooling students receive (Ramos, 2015). So another way of learning that goes beyond formal learning in the classroom has been recommended, although it is

not yet defined which modality would allow the experience of real situations in the business world.

If, on the one hand, the importance of teaching methods based on practice is noted, on the other hand, it is observed that the notion of practice has also permeated the Administration's research agenda, most notably since the 1990s. Since then, authors such as Lave (1991), Easterby-Smith, Snell & Gherardi (1998), Nicolini, Gherardi & Yanow (2003), Antonacopoulou & Chiva (2007), Miettinen, Samra-Fredericks & Yanow), Bueger & Gadinger (2014), Krasny et al. (2017), Mccourt (2016), Lynch, Rowlands, Gale & Skourdombis (2017) and Grootenboer, Edwards-Groves & Choy (2017) highlight the need for studies that address learning practices, exploring how learning emerges in the process of action and human interaction. From the perspective of the research, learning is an object of research, as it means a specific theoretical field of organizational studies (Chiva & Alegre, 2005; Marshall, 2008; Versiani, Oribe & Rezende, 2013). In this field, situated learning (Lave & Wenger, 1991, Lave, 2013, Strati, 2014) is a theoretical direction or a specific perspective of learning studies based on epistemologies of practice (Brown & Duguid, 2001; Antonacopoulou, 2008; Corradi, Gherardi & Verzelloni, 2008, Bishop, 2013).

2.1 Situated Learning of Competencies and Social Practice

In the situated learning references (Lave, 1988, Didier & Lucena, 2008, Gudolle, Antonello & Flach, 2012) and in the studies on professional competences (Parry, 1996, Perrenoud, 1999, Le Boterf, 2003, Dutra, 2004, Zarifian, 2012, Chong, 2013, Dias Junior, Moreira, Stosick & Pereira, 2014), were found the conceptual set to base the theoretical composition of the research presented here. In addition, according to Freitas, Montezano and Odelius (2019), higher education institutions have sought to combine extracurricular activities with the theoretical knowledge produced in the academy. They aim to complement the theoretical content and promote economic and social development, as well as the advancement of science and technology (Freitas Jr, 2003). These activities often constitute opportunities for the development of management competencies, since they make possible a real contact with the organizational contexts and their complexities (Leite, 2009). Thus, with regard to the empirical object, it was observed that the student communities or, in this case, more specifically, the Engineering Competition Teams (ECTs) presented themselves as alternatives of learning to the traditional teaching situations. In ECTs, learning is always central and occurs as part of a process that places its members as

active participants in their activities, not as formal and classroom learning, but as collaborative and practical learning. The perspective of practice explains social phenomena in a procedural way without losing touch with the mundane nature of everyday life and the concrete and material nature of the activities with which people are involved. In this perspective, knowledge is seen as a form of mastery that is expressed in the competence to perform a social and material activity. One learns how to act, how to speak (and what to say), how to feel, what to expect and what things mean in situations of practicing (Nicolini, 2013).

Learning is a complex, multidimensional and multilevel process, whereby individuals acquire new qualities that increase and transform their arsenal of competencies (Pereira, Loiola, & Gondim, 2016). People learn on their own initiative or through incentives from others, for example, by stimuli offered by organizations. Although it is an essentially individual act, all learning involves the integration of two very different processes: an external process, of interaction between the individual and his social, cultural and material environment, and an internal psychological process of elaboration and acquisition of new knowledge and abilities (Illeris, 2013; Pereira, Loiola, & Gondim, 2016).

Individual learning is defined as a process of building professional competences that cover the cognitive, emotional and social planes in which the learner plays an active role. Learning can be perceived in the observation of the performance of the individual, because while learning can be conceived as the process by which the individual acquires knowledge and skills, competence is the mobilization and relevant application of the knowledge and skills acquired to the particular situation and the performance is the visible manifestation of these competencies (Abbad, 2013, Pereira, Loiola, & Gondim, 2016).

In the literature on learning, the use of formal and informal learning is frequently used (Malcolm, Hodkinson, & Colley, 2003). According to these authors, there are elements of formal learning in informal learning situations, as well as elements of informality in formal learning, both of which are inextricably interrelated. In organizations, formal learning, although intentionally constructed, often presents an "experiential" character (Antonello, 2011).

Informal learning, in turn, is an activity that occurs outside the curricula of courses and educational programs and involves the pursuit of knowledge and / or skills. It may also occur in a formally structured experience, based on specific activities for this purpose, that is, it may occur

in formal teaching processes, whether it is planned or not, as long as it involves some degree of awareness of what is being learned (Antonello, 2011). In their identification and evaluation, it is crucial that their contextual nature be considered, for example, in Lave and Wenger (1991), who consider that knowledge and skills, when acquired in social and concrete environments, result in a large part of participation in practices. From the social point of view, learning refers to how individuals interpret and / or attribute meaning to their experiences in practice, and considers them to be social beings, who learn collectively and who construct an understanding of the context around them (Lave & Wenger, 1991; Elkjaer, 2013). The transference of learning among individuals, in this work context, means the knowledge, skills, behaviors or attitudes they develop in practice (Veloso, Silva, Silva, & Caetano, 2015).

Therefore, in individual terms, learning in practice means acquiring knowledge and skills in an ongoing process of learning. Learning, in these terms, is not only reproduction, but also renewal and reformulation of knowledge and skills. Adopting this positioning, as well as identifying and seeking the integration between formal and informal learning, means broadening the possibilities of understanding the dynamic and complex process of learning in practice, in a more consistent and profound way.

Thus, situated learning is concerned with the study of mechanisms that contribute to the process of knowledge production, among them the development of professional competences. Professional competences are not restricted to a stock of theoretical knowledge embodied by individuals. Nor are they restricted to understanding the contents and dimensions of tasks (Fleury & Fleury, 2001). In this work, it is considered competence, as well as professionalism, as a set of related knowledge, skills and attitudes that affect performance in activities, by the knowledge, may, and feel like of individuals to act (Parry, 1996; Le Boterf, 2003).

This theoretical framework led to the research on the subject of learning in the practice of an Engineering Competition Team (ECT). ECTs are student communities that carry out the development of practical projects aimed at obtaining a product. The activities of these communities are driven by national and international competitions that comparatively evaluate the projects, putting to the test the knowledge, innovations and technologies developed by different teams. Examples of these competitions are those promoted by SAE Brasil (Society of Mobility Engineers), a non-profit association whose mission is to disseminate techniques and

knowledge related to mobility technology in its various forms: terrestrial, maritime and aerospace. Student association programs aim to provide acquired knowledge and skills and attitudes are demonstrated when students are confronted with management and technology issues in practice that require knowledge, may, and feel like to act (SAE Brazil, 2015).

The word practical, in its broad sense, encompasses professional knowledge, forms of teaching, entry and socialization into a professional community, and the repetition of an acquired skill. Practice holds the opposite direction of theory, though it often brings the notion of being complementary to it. Professions use the expressions "practice-based studies" or "practice-based theory" to emphasize learning from the direct experience in which each professional community is founded. In turn, organizational literature uses the term practice to refer to a "recurrent way of doing things" and to learning that occurs in work practices.

The approach to practice explains social phenomena in a procedural way without losing touch with the mundane nature of everyday life and the concrete and material nature of the activities with which we are all involved. From the perspective of practice, knowledge is seen as a form of mastery that is expressed in the competence to perform a social and material activity. Knowledge is always a way of knowing shared with others, a set of practical methods acquired through learning (Nicolini, 2013).

Among the different views on the practice, one should highlight the one that has tried to develop new understandings about the relation between knowledge and practice from a non-rationalist and non-cognitivist perspective (Gherardi & Perrotta, 2014). In practice knowledge is no longer conceived as something possessed, neither as something pre-existent to action, nor as a substance to be applied when and where it is needed. Authors like Shotter (2012) and Gherardi and Perrotta (2014) have adopted an approach that considers knowledge to be an situated activity, that is, something that people do together while they are involved in everyday social practices, where the distinction between knowledge and the doing ceases to exist. Thus, situated learning that occurs in the social practice of the team interweaves "knowing" to "doing" in the competencies that develops and contributes to the professional formation of those who participate in it. Competence exceeds the knowledge (knowledge) that a person possesses, encompassing also their abilities, that is, the knowledge put into practice and the attitudes (wanting to do), which result from the sum of knowledge and skills

(Neves, Carvalhinha, Muritiba, & Muritiba, 2017). Figure 1 summarizes and outlines this idea, representing the theoretical model that guided the empirical research presented in this paper:

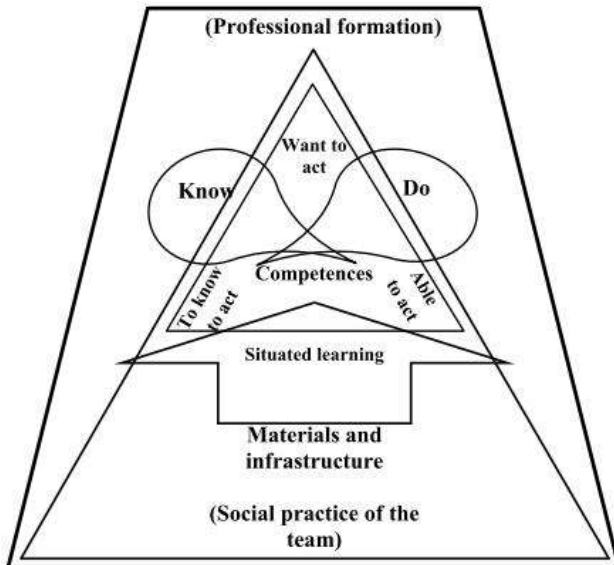


Fig.1: Theoretical model that guided this study.

Source: Own elaboration.

III. METHOD

This paper examined the social practice apprenticeship of an engineering competition team over a period of two years and three months. The focus on a single team is appropriate, since a good case study using the practice approach requires observational guidance and the adoption of methods that allow an appreciation of the practice as it happens (Nicolini, 2013). The team studied participates in the Baja SAE project (SAE Brazil, 2015), which is part of a student training program in which engineering students spontaneously organize teams to design and build small off-road cars. They compete representing their educational institution nationally and internationally. The idea of this program is that students apply, in practice, the knowledge acquired in the classroom and, in addition to complying with the requirements of the regulations of the competitions, innovate and undertake, differing positively from the other teams. By participating in the Baja SAE project the student becomes involved with a real case of developing a vehicle.

The team was formed at the end of 2011 by a group of students from a Federal University of the State of Minas Gerais - Brazil. The team consists of students from the Science and Technology and Mechanical Engineering courses. The total number of students participating in the team is around twenty-two. They are led by a student, designated as captain, and coordinated by a guest teacher.

The team is divided into two main sectors: management, and vehicle development. The management sector is composed of three departments: Finance, Marketing and Human Resources. The development sector of the vehicle, in turn, is composed of six departments, with a responsible director each: Suspension, Electronics, Steering, Structure, Transmission and Braking. Each director is responsible for the division of tasks in his department and for the presentation of the results obtained, the other directors, the captain and the coordinator.

3.1 Data collect

Three sources of evidence were used in the research: a) participant observations, synthesized in field journals written in notes and audios; b) photographs and; c) individual interviews in depth, semi-structured, recorded and transcribed. Participant observation was chosen because it is a modality of observation in which the researcher is not simply a passive observer, being able to assume several roles in the experience with the team and actually participate in the events that are being studied. Thus, during alternating periods, sixty visits were made to the team. In addition, one of the researchers accompanied the team in one of the competitions held in Piracicaba / SP. Records of the observations were recorded and annotated. After leaving the site, the observations were reported in the so-called "field diary", made in a text file on the computer. Sixty field diaries were thus obtained.

The photographs present an essential element in the analysis of the meanings constructed, inculcated and transmitted by the social environment. The analysis of the observer goes through a process of negotiation of meaning that transcends the image itself and can be read as a text and pointed as an objective record and testimony, a copy or a faithful transcription of a moment of reality. In this way photography is a process of legitimate abstraction of observation, since it transforms common data into circumstances for the elaboration of the analysis in the research (Almeida, 2007). In this work, eighty-seven photographs were used. They sought to capture the details of the learning aspects associated with community practice. The images seek to capture and transmit what is not very efficient on the linguistic plane, such as the distinction between situations where prevails the "knowing" (studying, designing, etc.), or the "doing" (sanding, cutting, mounting etc.) Thus, the photographs showed community-based learning. In it, team members appear to be studying vehicle systems (knowing); sanding the vehicle fairing, twisting and cutting steel tubes (do) and; designing and assembling the vehicle, activities

involving knowing, willing and able to act and requiring knowledge, skills and attitudes.

The in-depth, semi-structured interviews were adopted as the third source of evidence because they contain characteristics that make them appropriate to the situation, such as the fact that they can be opened and take a conversational way, allowing unpublished comments. The interviews included directors, the captain, the coordinator and current members, as well as some founding members who are no longer on the team. In addition, we interviewed the current ICT director and deputy director, the team leader at the time of the team's inception, current team coordinator, and current mechanical engineering course coordinator, totaling nineteen interviews. The interviews were carried out in person using a tape recorder. It is noteworthy that, both with respect to the observation and the interviews, an iterative process of advances and returns between the empirical data and the emerging analyzes occurred, making the data collection progressively more focused and the analyzes successively more theoretical (Pinto & Santos, 2012).

3.2 Data analysis

The analysis of the data was based on content analysis, the technique of which is to classify the different elements into "drawers", according to criteria that could give rise to a sense and introduce some order in the initial confusion. Specifically, content analysis is a set of methodological tools that, through objective and systematic procedures, describe the content of extremely varied communications messages (Nodari, Soares, Wiedenhoft, & Oliveira, 2014).

Following the recommendations of the literature (Gray, 2012; Nodari, Soares, Wiedenhoft & Oliveira, 2014), we sought to understand and interpret each unit decomposed from the original message. In this way, each unit of analysis could be constituted as much of words and subjects as of objects, individuals or events. This choice helped to verify the frequency of certain terms or topics and facilitated the identification of the content and characteristics of the information present in the text. The analysis was divided into two phases:

1) A pre-analysis was carried out by means of a floating reading of the material, the choice of the documents to be analyzed, the preparation of the indicators that would support the interpretation, and the preparation and organization of the material;

2) It was then moved to the exploration and codification phase of the material. Using the semantic classification criterion, which is constituted by thematic

categories, the coding was performed in three stages: open coding, axial coding and selective coding.

Open coding sought to express data and phenomena in the form of concepts, through the production of a list of codes and categories, with the aim of elaborating a more detailed understanding of the text. Axial coding has improved and differentiated categories from open coding, resulting in the following categories: knowing, doing, learning and academic schooling. In the selective coding the essential category was elaborated around which the other categories were developed and grouped, giving continuity to the axial codification in a higher level of abstraction. In this work the essential category was learning.

The MAXQDA software (VERBI GmbH, 2017) was used for the exploration and coding of the material. MAXQDA is a professional software for analyzing qualitative data and mixed methods of investigation, which assists the analysis of all types of unstructured data, such as interviews, scientific articles, multimedia files, questionnaires, social networking data, among many others possibilities. The software also allows you to encode audio and video files directly, without having to create a transcript, or transcribe the multimedia files and then perform an analysis of the text, as done in this work with interviews, recordings of meetings and recordings of the field diary observations. MAXQDA also allows quantifying the results of qualitative analyzes and calculating statistical frequencies in a simple and direct way (VERBI GmbH, 2017).

IV. RESULTS

In order to understand how the learning, which occurs in the practice of a ECT, contributes to the professional formation of the students participating in it, it was sought to detect in the data the alignment between the situated learning and the consequent contribution to the professional formation required by the Marketplace. It was noted that such alignment results from a relationship between the situated learning and the professional formation that, in the ECT, happens in the interweaving of knowledge when doing that occurs in the professional competences that are developed by the learning.

Then, taking the model formulated to base this study (Figure 1), the memories of the coexistence with the team and the data contained in the documents (diaries, photographs and interviews), was set up the process that shows how the situated learning that occurs in the practice of ECT results in the development of competences in its participants. Thus, the search for knowledge, individually or collectively, unrelated to

doing, implies learning that results in that portion of knowledge that, in the model represented in figure 1, lies in the gap between the triangle that represents the competences in development and the larger triangle, which represents the practice of the team. Although it is imbued with meaning, it is devoid of doing. It, like formal classroom learning, does not develop competences.

Those who have taken over the model (Figure 1) seeking an understanding of what is being treated, will have noticed that there is still a part of the knowledge that is outside the triangle that represents the practice of the team, although it happens in ECT, and will question what that means. It turns out that ECT is also a collective space, used by its members to study and perform the extra room tasks required by the university's formal education. That portion of knowledge results, then, from a learning that, although it is part of the academic formation, is not directly related to the practice of the team, and does not result in the development of competence.

As in the process of knowledge acquisition, the development of skills also follows the same logic. It can be seen in the model (Figure 1) that there is a part of the doing done in the ECT, which is outside its practice. This doing represents those activities carried out in that collective space, which are not directly linked to the activities of the team. This is the case, for example, of the use of materials and the infrastructure of the team for practical classes, carried out by some teachers. In addition, one realizes a part of doing that, although it is imbued with meaning (who does know why and for what it is being done), this doing does not develop skills. This is represented in the model by the space between community practice and developing competences.

Therefore, it is only when shared actions involving acquired knowledge, developed skills and positive attitudes occur to what is presented as something necessary to the functioning and / or the production of the team is that a learning situation occurs in the practice of the same. It is in this sharing (language, communication) of ideas and meanings that new ideas are generated, new meanings are created and the understanding of things is broadened. This knowledge, when intertwined with a task that requires previous skills and simultaneously develops new skills, with the process being moved by proactive attitudes, develops competences and contributes significantly to the professional formation of the participants.

MAXQDA software (VERBI GmbH, 2017) provided a detailed numerical description of the results obtained in each of the categories. Two examples of this description seek to synthesize the results achieved. Table 1 shows the

relationships between the categories and their respective sources of evidence:

Table 1: Overview of results

Categories	"Know"	"Do"	Learning	Academic formation	TOTAL
Field Diary	29	31	32	32	124
Photos	79	82	84	84	329
Interviews	28	22	45	45	140
TOTAL	136	135	161	161	593

Table 1 shows that, of the five hundred and ninety-three segments extracted from the sources of evidence and considered as categories in this study, one hundred and twenty-four are from the field journals, three hundred and twenty-nine are from the photographs and one hundred and forty are from interviews. One hundred and thirty-six belong to the category "Knowing", one hundred and thirty-five to "Doing", one hundred and sixty-one to learning and the same number to academic formation.

Table 2: Connections between codes

Categorias	"Know"	"Do"	Learning	Academic formation	TOTAL
"Know"	0	129	136	136	401
"Do"	129	0	135	135	399
Learning	136	135	0	161	432
Academic formation	136	135	161	0	432
TOTAL	401	399	432	432	1664

Table 2, in turn, shows the connections between the categories. By analyzing the two tables together, it is possible to deduce that, out of one hundred and sixty-one segments of the "Learning" category (Table 1), all are connected to the category "Academic formation", one hundred and thirty-six are connected to the "Knowing" and one hundred and thirty-five to "Doing" (Table 2). The interlacing between "Knowing" and "Doing" is also noted. Of the hundred and thirty-six segments extracted from the "Know" category, and the hundred and thirty-five segments of the "Do" category, one hundred twenty-nine appear connected.

V. FINAL CONSIDERATIONS

Problem solving is at the core of engineering practice and the technical work of engineers is inseparably interwoven with collaboration between team members (Passow & Passow, 2017). In this sense, besides the

specific technical competences, the current labor market has demanded, from the engineers, competences that contribute with the capacity to solve problems and to create products. It requires not only the enhancement of technology knowledge, but also the understanding of how modern business organizations function. An example of this is the knowledge requirements related to financial, marketing, legal and, above all, people (Hecklau, Galeitke, Flachs, & Kohl, 2016). According to a study conducted by the United Nations Educational, Scientific and Cultural Organization - UNESCO (2010), an engineer able to meet the challenges of the 21st century must have the following competencies: entrepreneurship, flexibility, ability to contribute to innovation, creativity, ability to deal with uncertainties, a sense of continued learning, social and cultural sensitivity, ability to communicate effectively, to work as a team and to take on new responsibilities. Among the important competences for engineering practice, teamwork is considered a transversal competence, a central topic of the knowledge and skills required (Sein-Echaluze & García-Peñalvo, 2016; Passow & Passow, 2017). These managerial competencies are objects of study, research and teaching in the Administration field, and are not included in the curriculum of most engineering courses in Brazil, with severe resistance from both teachers and students, as well as the incorporation of new activities, outside the so-called technical competencies (Confederação Nacional da Indústria, 2015). According to Passow and Passow (2017), teachers should jointly articulate and prioritize the competences that students must obtain in their formation, to prepare for life and career. The authors also argue that when faculty creates the specifications for creating a curriculum, they need to answer questions such as: "Among generic engineering competences, what is the importance of professional practice in disciplines and work contexts?"

In the professional field of engineering has been emphasized the importance of the development of managerial knowledge. The perceived shortage of qualified engineers in Brazil is aggravated, as the business sector expects these professionals to present personal skills that surpass traditional objective and quantitative reasoning. In this sense, students are expected to develop leadership characteristics and teamwork, entrepreneurship and general knowledge, whose dominance has been increasingly important for the schooling of the entrepreneurial and innovative engineer (Confederação Nacional da Indústria, 2015). The need for appropriate educational components to generate a "pre-work experience", linking the teaching activity to

business and the industrial environment is perceived (Ríos-Carmenado, López, & García, 2015). This need can be seen in the federal government's educational guidelines put to Engineering schools, which have been advised to improve the training of their students. This orientation is found in the "National Engineering Plan (Pro-Engineering): Brazilian Development - Winning the Challenges of the Decade 2011/2020" launched in September 2011 by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES-MEC, 2011). This plan, when presenting a detailed diagnosis of the schooling of engineers in Brazil, confirms the need to improve the teaching quality of this profession, prioritizing educational actions focused on solving concrete problems. One of the proposals of the plan is the implementation of innovation projects in schools so that the students have contact with the practice at the beginning of the course (Carneiro Júnior, 2010). Therefore, the main purpose of current engineering schooling should be to shift the focus from logical thinking (cartesian) to creative thinking, less theoretical and more experimental, less abstract and more concrete, emphasizing the competences empowerment of students.

It can be noticed that Engineering schooling in Brazil does not privilege the development of management competences and is still very focused on content with little contact with the "real world". There is, in Brazil, a chronic and widespread problem when it comes to laboratories that deal with real problems and that go beyond mere demonstrations or analysis of errors. Little attention is given to scientific results that can solve real problems. Students complain about the low relationship between theoretical and practical experience. Engineering schooling does not interweave the fundamental concepts of science and mathematics with the practice of the future profession. Students do not learn content from other areas that use methodologies other than operational and numerical in modeling, are not called attention to the application of scientific concepts in the possible use in future innovations and are not faced with practical challenges and environments that reproduce what they will find in industries. Therefore, the great challenge identified in the teaching of engineering in Brazil has been to train competent engineers in both their technical and managerial areas, stimulating proposals in which practice has a relevant role.

The connections between the categories analyzed in this study point to the fact that learning, which occurs in the practice of the community investigated, contributes to the academic formation of the students participating in it, developing the competences required by the market, and

providing the interweaving of the "Know" to "Do". No studies were found addressing the issue of learning in the practice of an ECT and, especially, studies in this type of student community, which deal with how this process contributes to the fulfillment of the epistemological and institutional gap that separates the conceptual and analytical knowledge of the situation cognitive model of action (Koike & Mattos, 2000). In other words, no work was found in this type of organization dealing with how this process contributes to filling the gap between "knowing" and "doing" (Pfeffer & Sutton, 2001). Therefore, we consider that addressing this gap, in the context of an ECT, is relevant in debates about learning and development of managerial competences in the formation of students who participate in them, as well as in other student communities. In comparison with other forms of learning, what happens in a community requires that its participants know how to do and what they do, and thus constitute a form of acquisition of knowledge and skills of strategic importance for the formation of students from the so-called "professional" areas.

REFERENCES

- [1] Abbad, G. d. (2013). Aprendizagem em organizações e no trabalho. In: L. O. Borges, & L. (MOURÃO, O trabalho e as organizações: atuações a partir da psicologia (pp. 467-527). Porto Alegre: Artmed.
- [2] Almeida, S. B. (2007). O uso da fotografia na pesquisa. Diálogos Possíveis, 115-129.
- [3] Antonacopoulou, E. P. (2008). On the practise of practice: in-tensions and ex-tensions in the ongoing reconfiguration of practices. In: D. Barry, & H. Hansen, New approaches in management and organization (pp. 112-131). London: SAGE.
- [4] Antonacopoulou, E., & Chiva, R. (2007). The Social Complexity of Organization Learning: The Dynamics of Learning and Organizing. Management Learning, 38(3), pp. 277-295. doi/10.1177/1350507607079029.
- [5] Antonello, C. S. (2007). Aprendizagem na ação revisitada e seu papel no desenvolvimento de competências. Aletheia, 146-167.
- [6] Antonello, C. S. (2011). Saberes no singular? Em discussão a falsa fronteira entre aprendizagem formal e informal. In: C. S. Antonello, & A. S. Godoy, Aprendizagem organizacional no Brasil (pp. 225-245). Porto Alegre: Bookman.
- [7] Antonello, C. S., & Ruas, R. (2005). Formação gerencial: pós-graduação lato sensu e o papel das comunidades de prática. Revista de Administração Contemporânea, 9(2), 35-58. <http://dx.doi.org/10.1590/S1415-65552005000200003>.
- [8] Bispo, M. (jan./abr de 2013). Estudos Baseados em Prática: Conceitos, História e Perspectiva. RIGS revista interdisciplinar de gestão social, 2(1), 13-33.
- [9] Brown, J. S., & Duguid, P. (2001). Knowledge and Organization: A Social-practice Perspective. Organization Science, 12(2), 198-213. <https://doi.org/10.1287/orsc.12.2.198.10116>.
- [10] Bueger, C., & Gadinger, F. (2014). International practice theory: new perspectives. Basingstoke: Palgrave Macmillan.
- [11] CAPES-MEC. (Julho de 2011). Plano Nacional de Engenharia (Pro-Engenharia). Acesso em 12 de Junho de 2016, disponível em UERG: <http://www.eng.uerj.br/publico/anexos/1318898639/>
- [12] Carneiro Júnior, S. (14 de setembro de 2010). Uol Educação. (A. Ciegliński, Produtor) Acesso em 24 de maio de 2016, disponível em <http://educacao.uol.com.br/noticias/2010/09/14/programa-pro-engenharia-quer-dobrar-numero-de-profissionais-formados-no-brasil.htm>
- [13] Cavedon, N. R. (2014). Método etnográfico: da etnografia clássica às pesquisas contemporânea. In: E. M. Souza, Metodologias e análises qualitativas em pesquisa organizacional (pp. 65-92). Vitória: EDUFES.
- [14] Chiva, R., & Alegre, J. (2005). Organizational learning and organizational knowledge: towards the integration of two approaches. Management Learning, 36(1), 49-68. <https://doi.org/10.1177/1350507605049906>.
- [15] Chong, E. (2013). Managerial competencies and career advancement: a comparative study of managers in two countries. Journal of Business Research, 345-353.
- [16] Clyde, P. (2015). Skill-Building Through Business Education. Stanford Social Innovation Review, 1-3.
- [17] Confederação Nacional da Indústria. (2015). Fortalecimento das engenharias. Brasília: CNI.
- [18] Corradi, G., Gherardi, S., & Verzelloni, L. (2008). Ten good reasons for assuming a 'practice lens' in organization studies. Acesso em 20 de Maio de 2015, disponível em Site da Warwick: <http://www2.warwick.ac.uk/fac/soc/wbs/conf/olkc/archive/olkc3/papers/contribution312.pdf>
- [19] Deiglmeier, K. (13 de Setembro de 2013). Inovação social faz país rico aprender com pobre. (P. Gomes, Produtor) Fonte: Porvir inovações em educação: <http://porvir.org/inovacao-social-faz-pais-rico-aprender-pobre/>
- [20] Dias Junior, C. M., Moreira, B. C., Stosick, E. Z., & Pereira, A. R. (2014). Desenvolvimento de competências do administrador: um estudo em ambiente simulado. Revista de Ciências da Administração, 16(38), 172-182. doi:<https://doi.org/10.5007/2175-8077.2014v16n38p172>.
- [21] Dias, G. B., Becker, G. V., Dutra, J. S., Ruas, R., & Ghedine, T. (2013). Revisando a noção de competência na produção científica em administração: avanços e limites. In: J. S. Dutra, M. T. Fleury, R. Ruas, & (Org.), Competências: conceitos, métodos e experiências (pp. 9-30). São Paulo: Atlas.
- [22] Didier, J. M., & Lucena, E. d. (Janeiro/Março de 2008). Aprendizagem de Praticantes da Estratégia: contribuições

- da aprendizagem situada e da aprendizagem pela experiência. *O&S*, 15(44), pp. 129-148.
- [23] Dutra, J. S. (2004). *Competências*. São Paulo: Atlas.
- [24] Easterby-Smith, M., Snell, R., & Gherardi, S. (1998). Organizational learning: diverging communities of practice? *Management Learning*, 29(3), pp. 259-272.
- [25] Elkjaer, B. (2013). Pragmatismo: uma teoria da aprendizagem para o futuro. In: K. (. Illeris, *Teorias contemporâneas da aprendizagem* (pp. 91-108). Porto Alegre: Penso.
- [26] Farjoun, M., Ansell, C., & Boin, A. (2015). PERSPECTIVE—Pragmatism in Organization Studies: Meeting the Challenges of a Dynamic and Complex World. *Organization Science*, 26(6), 1787-1804.
- [27] Fischer, A. L., Dutra, J. S., Nakata, L. E., & Ruas, R. (2013). Absorção do conceito de competência em gestão de pessoas: a percepção dos profissionais e as orientações adotadas pelas empresas. In: J. S. Dutra, M. T. Fleury, & R. (. Ruas, *Competências: conceitos, métodos e experiências* (pp. 31-50). São Paulo: Atlas.
- [28] Fleury, M. T., & Fleury, A. (2001). Construindo o Conceito de Competência. *RAC*(Edição Especial), 183-196.
- [29] Freitas Jr, O. G. (2003). Um modelo de sistema de gestão do conhecimento para grupos de pesquisa. Tese de Doutorado. Programa de Pós-Graduação em Engenharia de Produção. Universidade Federal de Santa Catarina. Disponível em <<http://repositorio.ufsc.br/xmlui/handle/123456789/85845>>
- [30] Freitas, P. F., Montezano, L., & Odelius, C. C. (Janeiro de 2019). A influência de Atividades Extracurriculares no Desenvolvimento de Competências Gerenciais em Grupos de Pesquisa. *Administração: Ensino e Pesquisa (RAEP)*, 20(1), 12-49. doi:<https://doi.org/10.13058/raep.2019.v20n1.1070>.
- [31] Gherardi, S., & Perrotta, M. (2014). Between the hand and the head; How things get done, and how in doing the ways of doing are discovered. *Qualitative Research in Organizations and Management: An International Journal*, 9(2), 134-150.
- [32] Gray, D. E. (2012). *Pesquisa no mundo real* (2ª ed.). Porto Alegre: Penso.
- [33] Grootenboer, P., Edwards-Groves, C., & Choy, S. (2017). Practice theory perspectives on pedagogy and education: praxis, diversity and contestation. Singapore: Springer Nature.
- [34] Gudolle, L. S., Antonello, C. S., & Flach, L. (Fevereiro de 2012). Aprendizagem situada, participação e legitimidade nas práticas de trabalho. *RAM, Rev. Adm. Mackenzie*, 13(1), pp. 14-39. <http://dx.doi.org/10.1590/S1678-69712012000100002>.
- [35] Hecklau, F., Galeitzke, M., Flachs, S., & Kohl, H. (2016). Holistic approach for human resource management in Industry 4.0. Elsevier B.V.(*Procedia CIRP*), 54, pp. 1-6. <https://doi.org/10.1016/j.procir.2016.05.102>.
- [36] Illeris, K. (2013). Uma compreensão abrangente sobre a aprendizagem humana. In: K. (. Illeris, *Teorias contemporâneas da aprendizagem* (pp. 15-30). Porto Alegre: Penso.
- [37] Koike, K., & Mattos, P. L. (Setembro de 2000). Entre a Epistêmê e a Phrónesis: Antigas Lições para a Moderna Aprendizagem em Administração. Acesso em 23 de Setembro de 2015, disponível em Site da ANPAD - XXIV Encontro da ANPAD: http://www.anpad.org.br/~anpad/eventos.php?cod_evento=1&cod_evento_edicao=4&cod_edicao_subsecao=51&cod_edicao_trabalho=4324
- [38] Krajewski, L., Ritzman, L., & Malhotra, M. (2009). *Administração de produção e operações*. São Paulo: Pearson Prentice Hall.
- [39] Krasny, M. E., Silva, P., Barr, C., Golshani, Z., Lee, E., Ligas, R., . . . Reynosa, A. (2015). Civic ecology practices: insights from practice theory. *Ecology and Society*, 20(2).
- [40] Lave, J. (1988). *Cognition in practice: mind, mathematics, and culture in everyday life*. Cambridge: Cambridge University Press.
- [41] Lave, J. (1991). *Cognición en la práctica*. Barcelona: Paidós.
- [42] Lave, J. (2013). A prática da aprendizagem. In: K. Illeris, *Teorias contemporâneas da aprendizagem* (pp. 235-245). Porto Alegre: Penso.
- [43] Lave, J., & Wenger, E. (1991). *Situated learning: legitimate peripheral participation*. Cambridge: Cambridge University Press.
- [44] Le Boterf, G. (2003). *Desenvolvendo a competência dos profissionais*. Porto Alegre: Artmed.
- [45] Leite, M. T. (2009). Desenvolvimento de competências gerenciais e aprendizagem experiencial: um estudo entre os gerentes de agência do Banco do Brasil no Estado do Ceará. XXXIII Encontro da ANPAD, 33, 2009, São Paulo. Anais... São Paulo: ANPAD, Disponível em <<http://www.anpad.org.br/admin/pdf/GPR3246.pdf>>.
- [46] Lynch, J., Rowlands, J., Gale, T., & Skourdombis, A. (2017). *Practice theory and education: diffractive readings in professional practice*. New York: Routledge.
- [47] Malcolm, J., Hodkinson, P., & Colley, H. (2003). The interrelationships between informal and formal learning. *Journal of Workplace Learning*, 15(7/8), 131-318.
- [48] Marshall, N. (Sept de 2008). Cognitive and practice-based theories of organizational knowledge and learning: incompatible or complementary? *Management Learning*, 39(4), pp. 413-435.
- [49] Mccourt, D. M. (28 de September de 2016). Practice theory and relationalism as the new constructivism. *International Studies Quarterly*, 60(3), 475-485. <https://doi.org/10.1093/isq/sqw036>.
- [50] Miettinen, R., Samra-Fredericks, D., & Yanow, D. (2009). *Re-Turn to Practice: An Introductory Essay*. *Organization Studies*, 30(12), 1309-1327.
- [51] Neves, A. C., Carvalhinha, P. U., Muritiba, P. M., & Muritiba, S. N. (2017). Diagnóstico e análise das

- competências dos conselheiros de Administração. RAE-Revista de Administração de Empresas, 57(5), 453-469. <http://dx.doi.org/10.1590/s0034-759020170504> .
- [52] Nicolini, D. (2013). *Practice Theory, Work & Organization: an introduction* . Oxford: Oxford University Press.
- [53] Nicolini, D., Gherardi, S., & Yanow, D. (2003). *Knowing in Organizations: A Practice-Based Approach*. (D. Nicolini, S. Gherardi, & D. Yanow, Eds.) Armonk, NY: M.E. Sharpe.
- [54] Nodari, F., Soares, M. d., Wiedenhof, G. C., & Oliveira, M. (2014). Contribuição do Maxqda e do NVivo para a Realização da Análise de Conteúdo. Rio de Janeiro: EnANPAD 2015 - .
- [55] Parry, S. B. (July 1996). The quest for competencies. *Training*, 33(7), 48-54.
- [56] Passow, H. J., & Passow, C. H. (2017). What Competencies Should Undergraduate Engineering Programs Emphasize? A Systematic Review. *Journal of Engineering Education (JEE)*, 106(3), pp. 475-526. <https://doi.org/10.1002/jee.20171>.
- [57] Pereira, L. M., Loiola, E., & Gondim, S. M. (Jul./Set. de 2016). Aprendizagem de competências, suporte à transferência de aprendizagem e desempenho docente: evidências de validação de escala e teste de relações. *Organizações & Sociedade*, 23(78), 438-459.
- [58] Perrenoud, P. (1999). *Construir as competências desde a escola*. Porto Alegre: Artes Médicas Sul.
- [59] Pfeffer, J., & Sutton, R. I. (2001). A armadilha da conversa inteligente. In: H. B. Review, *Aprendizagem Organizacional* (pp. 27-47). Rio de Janeiro: Campus.
- [60] Pinto, M. R., & Santos, L. L. (2012). A Grounded Theory como abordagem metodológica: relatos de uma experiência de campo. *Organizações & Sociedade*, 19(62), 417-436.
- [61] Ramos, M. N. (2015). Pode haver um apagão generalizado de professores. (F. Y. OSHIMA, Produtor) Acesso em 3 de Abril de 2019, disponível em Época: <https://epoca.globo.com/ideias/noticia/2015/10/mozart-neves-ramos-pode-haver-um-apagao-generalizado-de-professores.html>
- [62] Ríos-Carmenado, I. d., López, F. R., & García, C. P. (2015). Promoting Professional Project Management Skills in Engineering Higher Education: Project-Based Learning (PBL) Strategy. *International Journal of Engineering Education*, 31(1B), pp. 184-198.
- [63] SAE Brasil. (2015). SAE BRASIL. Acesso em 22 de março de 2014, disponível em Site da SAE BRASIL: http://saebrazil.org.br/eventos/programas_estudantis/baja2015/Exibe.aspx?codigo=1011
- [64] Schommer, P. C. (2005). *Comunidades de prática e articulação de saberes na relação entre universidade e sociedade*. Tese de doutorado, FGV/EAESP, São Paulo.
- [65] Sein-Echaluce, M. L.-B., & García-Peñalvo, F. J. (2016). Students' Knowledge Sharing to Improve Learning in Academic Engineering Courses. *International Journal of Engineering Education (IJEE)*, 32(2B), pp. 1024-1035.
- [66] Shotter, J. (2012). Knowledge in transition: the role of prospective, descriptive concepts in a practice-situated, hermeneutical-phronetic social science. *Management Learning*, 43(3), 245-260. <https://doi.org/10.1177/1350507612437679>.
- [67] Strati, A. (2014). Conhecimento sensível e aprendizagem baseada na prática. In: S. Gherardi, & A. Strati, *Administração e aprendizagem na prática* (pp. 61-81). Rio de Janeiro: Elsevier.
- [68] United Nations Educational, Scientific and Cultural Organization. (2010). *Engineering: Issues, Challenges and Opportunities for Development*. Paris: UNESCO.
- [69] Veloso, A. L., Silva, M. J., Silva, I., & Caetano, A. (2015). Fatores que afetam a transferência da aprendizagem para o local de trabalho. RAE-Revista de Administração de Empresas, 55(2), 188-201. <http://dx.doi.org/10.1590/S0034-759020150208>.
- [70] VERBI GmbH. (2017). MAXQDA The art of data analysis. Fonte: <http://www.maxqda.com/portuguese>
- [71] Versiani, A. F., Oribe, C. Y., & Rezende, S. F. (JUL./AGO de 2013). A aprendizagem das organizações gerada pelas práticas formais no ambiente de trabalho. *Revista de Administração Mackenzie*, 14(4), pp. 15-44. <http://dx.doi.org/10.1590/S1678-69712013000400002>.
- [72] Zarifian, P. (2012). *Objetivo competência: por uma nova lógica*. São Paulo, SP: Atlas.

PBL in the development and stability control of an UAV with interdisciplinarity between digital control and computer assisted design

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Abstract—Considering the difficulty of the members of the engineering courses in applying theoretical knowledge in practical situations, the proposals of Project-Based Learning (PBL) and experimental materials aim to expose the student to the professional reality applying the theoretical knowledge learned in the classroom and laboratories of experiments. Applying ABP in the discipline of Digital Control, it was proposed that the students develop a drone, a technology that for their implementation needs the application of the knowledge of digital control, electronics, mechanics, programming and modeling in Computer Aided Design (CAD) software. At the end are presented the results that the project has brought to the learning of the disciplines on the optics of the tutor and students.

Keywords—PBL, Interdisciplinary, Stability control, Digital Control. Drone. Computer Assisted Design.

I. INTRODUCTION

A major difficulty for students entering on engineering degrees is to apply theoretical knowledge and visualize practical situations in their professional reality [1]. Aimed at applying theoretical knowledge and exposing students to the challenges of professional reality, Project Based Learning (PBL), which consists of a learning style that seeks to expose students to new challenges, can be applied through the development of a Unmanned Aerial Vehicle (UAV), or drones, as they are best known, as a means of visualizing the application of the theory [2].

The usage of drones is growing in several areas and becoming one of the most commercialized technologies. Thus, the development of projects that allows the learning of technology gets a lot of prominence in the academy [3]. This technology allows the application of subjects commonly seeing in the course of Engineering of Control and Automation, such as digital controls, algorithms and many others [2].

This article aims to exhibit the development and stability control of a drone through practices in the Digital Control module of the University of Fortaleza (UNIFOR).

II. PROTOTYPE

The students developed in the Solid Works software the parts that make up the drone to be used in the Digital Control practices so that the complete structure behaves (or fits) with the components available in the laboratory, they are: motors and propellers model SIMA x5 Fig. 1A); ESP32 microcontroller (Fig. 1B); and MPU6050 accelerometer / gyroscope module (Fig. 1C). In addition to the drone structure itself, a pyramidal base was also designed to serve as a support for calibration tests, the complete design can be seen in Fig. 2. The prototype was printed in 3D, as shown in Fig. 3. The files needed to the structure was made available to the students, however, the possibility of using other structures and / or components was at their discretion.

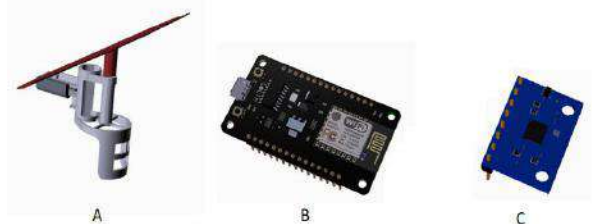


Fig. 1: 3D model of the components available in the laboratory

Source: Authors

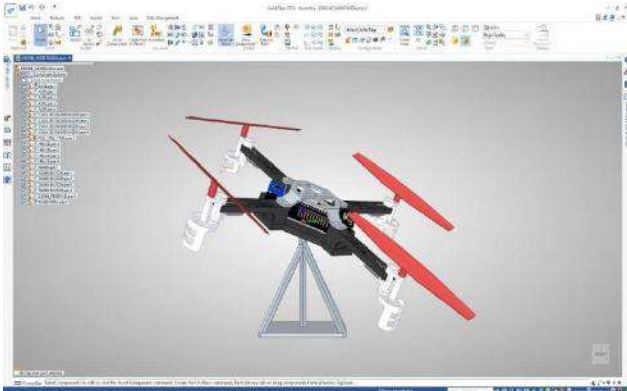


Fig. 2: 3D drone design in SolidWorks software

Source: Authors



Fig. 3: Drone's parts printed in 3D

Source: Authors

III. DEVELOPMENT

Drones like quadcopters consist of complex electromechanical dynamic systems. In order to keep a quadcopter as stable as necessary, a robust control is required. Ogata [4] explains that digital control systems are systems that have a digital computer, which is responsible for processing the control of the system and controlling the dynamics of the system. According to the control theory, control systems constitute processes and subsystems that are constructed in order to obtain a response from a given input [5].

Closed-loop control systems, also called feedback control systems, operate through response measurements, comparing the response obtained with the desired response and with that, obtaining the error. From this, they alter their performances on the system in order to minimize the error[5].

The PID controller is an example of a viable controller to stabilize a drone, as pointed by Babu [6], because it acts on the system through the sum of three

operations calculated over the error obtained, by the feedback system of control. Each operation has its relevance determined by different coefficients, the synchronization of those make a successfully control to occur and the behavior to be as desired [7]. The PID controller can be represented mathematically by equation (1).

$$u(t) = K_p e(t) + K_i \int_0^t e(T) dT + K_d \frac{de(t)}{dt} \quad (1)$$

The works of Prakosa [8] and Devos, Ebeid and Manoon-pong [9] explain that in order to achieve stability during flight of a drone, the directions of rotation of the propellers must be alternated as shown in Fig. 4, where the rotors of number 1 and 3 rotates clockwise while those of numbers 2 and 4 rotate in the opposite direction. Thus, if the speeds of motors 1 and 3 are greater than those of motors 2 and 4, the drone will rotate on its own axis in the clockwise direction and vice versa. The altitude can be controlled from the speed of rotation of its four propellers together. The forward and backward tilt is given by operating on motor pairs 3 and 4 or 1 and 2 in this order, while for left and right pairs 2 and 3 or 1 and 4, also in this order.

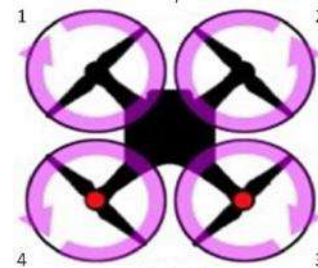


Fig. 4: Rotor schematic.

Source: Authors

The PID controller, presented in equation (1), needs to be modified to transform it into an algorithm that can be implemented on a digital platform such as a microcontroller. These modifications are necessary because Equation (1) is written in the continuous time domain while the ESP32, as a digital platform, operates in the discrete time domain. Yang and Bi [10] state that for the implementation of the PID in microcontrollers should use the formulation below, as presented in equation (2):

$$u(t) = K_p e(t) + K_i \sum e(t) * dt + K_d \frac{(e(t) - e(t-1))}{dt} \quad (2)$$

Where and (t) is the difference between the desired value, or setpoint, and the value obtained. In this way, the PID controller has the same operation and result, but with this definition the algorithm is easier to

implement in a digital systems. The generated algorithm follows the flow shown in Fig. 5.

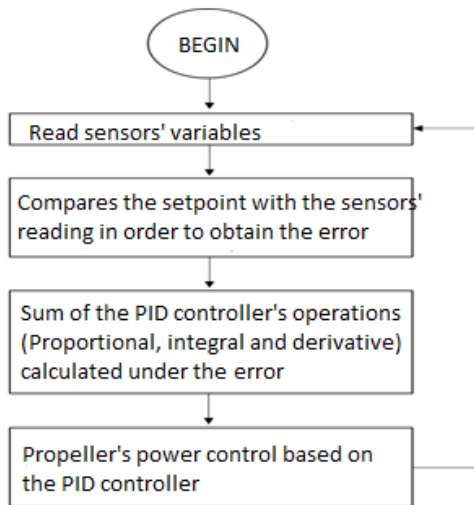


Fig. 5: PID controller algorithm
Source: Authors

3.1 Sensors Reading

In order to read the data from the guidance and motion of the drone, this work uses an MPU6050 module, which has embedded in its hardware a 3-axis accelerometer sensor and a 3-axis gyroscope. From those sensors it is capable of measure the angles related to X, Y and Z, known in aviation as yaw, pitch and roll. These axes are represented in Fig. 6.

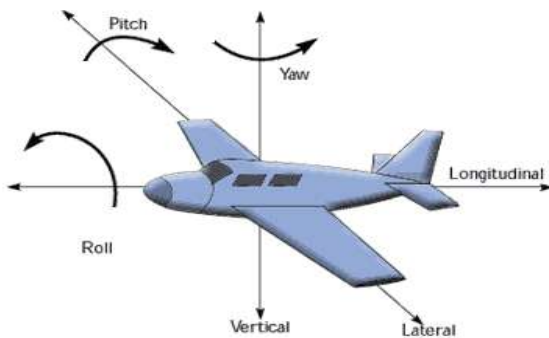


Fig. 6: Representation of common flying axis
Source: Novatel [11]

The work of Carlos et al. [12] converts the values of the acceleration data (ax, ay, and az) to the degree of slope relative to the earth's surface. These conversions are obtained through the application of equations (3), (4) and (5).

$$X = \arctan\left(\frac{ax}{\sqrt{ay^2 + az^2}}\right) * \frac{180}{\pi} \quad (3)$$

$$Y = \arctan\left(\frac{ay}{\sqrt{ax^2 + az^2}}\right) * \frac{180}{\pi} \quad (4)$$

$$Z = \arctan\left(\frac{az}{\sqrt{ax^2 + ay^2}}\right) * \frac{180}{\pi} \quad (5)$$

Similarly to what was done with the acceleration data of the MPU6050, the data of the gyroscope was also transformed into a more usual unit to facilitate the understanding and the development of the applications. Equations (6), (7) and (8) represent the calculation for transforming the values gx, gy and gz, which are gross values of the read rotations respectively for the X, Y and Z axes, for vX, vY and vZ, which are values of the turns in degrees per second for the X, Y and Z axes, respectively. The constant g_gain is the calibration constant for the resolution set at the sensor; it is informed in the datasheet of the gyroscope.

$$vX = gx * g_gain \quad (6)$$

$$vY = gy * g_gain \quad (7)$$

$$vZ = gz * g_gain \quad (8)$$

According to Baerveldt and Klang [13], the readings made by accelerometers are quite sensitive to vibration noises. Because of that, it is important to use a filter in order to improve the accuracy of measurements. Baerveldt and Klang [13] recommend the application of the complementary filter, which integrates the readings of an accelerometer and a gyroscope into a single orientation result. The equations (9), (10) and (11) show the application of the complementary filter, where:

$$FiltX = AA * (FiltX + gX \text{int} * dT) + (1 - AA) * X \quad (9)$$

$$FiltY = AA * (FiltY + gY \text{int} * dT) + (1 - AA) * Y \quad (10)$$

$$FiltZ = AA * (FiltZ + gZ \text{int} * dT) + (1 - AA) * Z \quad (11)$$

Where FiltX, FiltY and FiltZ are respectively the values of the angles of the X, Y and Z axes obtained with the usage of the complementary filter. AA is the consideration factor of the accelerometer in sensors' joint. This value determines the confidence of the values obtained by the accelerometer. A value between 0 and 1 must be chosen for the variable. gXint, gYint and gZint which are integrals of the turns in the X, Y and Z axes, respectively, those values can be obtained through the usage of the Equations (11), (12) and (13), where dT is the time taken to re-sample the MPU6050 readings.:

$$gX \text{int} = gX \text{int} + vX * (dT) \quad (9)$$

$$gY_{int} = gY_{int} + vY * (dT) \tag{10}$$

$$gZ_{int} = gZ_{int} + vZ * (dT) \tag{11}$$

3.2 Classroom practices

In the classroom practice, students were challenged to implement and calibrate a robust PID controller for altitude (Fig. 7 item 1) and rotation axis (Fig. 7 items 2, 3 and 4). Controllers can / should be tested and calibrated separately. In a second moment, all the controllers were implemented simultaneously. The applied source code, can be found on github through the link: <https://github.com/afonsohfontes/DroneStabilityControl>, while the videos footage of the results, can be seeing using the following links: <http://youtu.be/gNNePRGetCc>, <http://youtu.be/07HaDTp5J7c> and http://youtu.be/fimDQZ_pDu0.



Fig. 7: Structures used for PID tests

Source: Authors

IV. CONCLUSION

This work put together the knowledge acquired in classroom and laboratory's experiments, using the principals of the Project Based Learning (PBL) in order to develop the drone, where the knowledge and techniques that the course of Engineering of Control and Automations demands, reducing the gap between the academic environment and the labour market. The students who choose to develop the project became more experienced and more prepared to deal with problem situations during the course or in their professional career, as expected from the application of PBL. The learning of the students about the themes approached in the module, can be confirmed through the results obtained, the project explanation given by them and the success of the project. According to Babu, Das and Kumar [6] for the teams that developed this project, many opportunities will be open with the addition of this work in their resúmenes.

As a result of this work a was built a experimental prototype of good quality and low cost that could be used

by other students of the module of Digital Control of the University of Fortaleza, in the application and simulation of control algorithms.

The students who participated in the practices reported in this study answered a questionnaire containing the questions raised by the tutor. All the questions asked could be answered on a scale of 1 to 5, where 1 would be the most possible negative answer and 5 to most positive. Fig. 8 depicts how motivated the students were during practice, while Fig. 9 shows how challenging the proposed project was for them. In a universe of 15 students it is noticed that 80% of them saw the project as very challenging and yet 93.3% of them felt motivated or very motivated. It is noted from Fig. 10 and 11 that all students support the application of PBL and that this practice helped them to better understand the content of the digital control discipline, great motivator of the accomplishment of this interdisciplinary work. Ofpossession of the results obtained in this project, we observe the possibility of the constant use of drones in the discipline of Digital Control, with the purpose of amplifying the student's development, facilitating the comprehension of the studied content.

Did you feel motivated doing the proposed activities?

15 answers

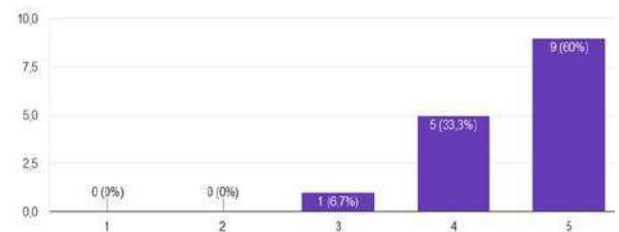


Fig. 8: Research with the students who did the practice

Source: Authors

In your opinion, how challenging was the proposed project?

15 answers

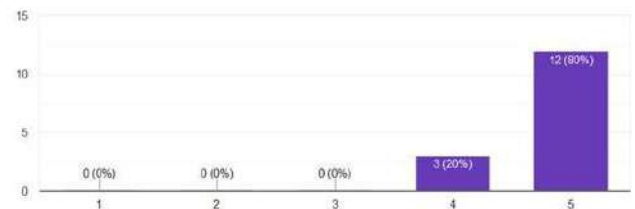


Fig. 9: Research with the students who did the practice

Source: Authors

How much did the project help you understand the content of the Digital Control discipline?

15 answers

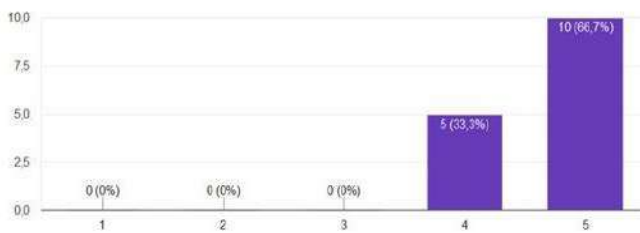


Fig. 10: Research with the students who did the practice

Source: Authors

Do you support Project-Based Learning?

15 answers

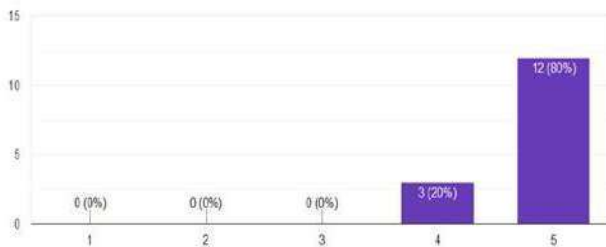


Fig. 11: Research with the students who did the practice

Source: Authors

REFERENCES

- [1] RAPKIEWICZ, C. E.; FALKEMBACH, G. A. M.; SEIXAS, L. M. J. d.; SANTOS, N. d. S.R. S.; CUNHA, V. V. d.; KLEMANN, M. et al. Estratégias pedagógicas no ensino de algoritmos e programação associadas ao uso de jogos educacionais. **RENTE: revista novas tecnologias na educação [recurso eletrônico]**. Porto Alegre, RS, 2007.
- [2] RAHMAN, M.; ANI, A.; YAHAYA, S.; HUSSAIN, Z.; BOUDVILLE, R.; AHMAD, A. Implementation of quadcopter as a teaching tool to enhance engineering courses. In: IEEE. **2016 IEEE 8th International Conference on Engineering Education (ICEED)**. [S.l.], p. 32–37. 2016.
- [3] SATTAR, F.; TAMATEA, L.; NAWAZ, M. Droning the pedagogy: Future prospect of teaching and learning. **International Journal of Educational and Pedagogical Sciences**, v. 11, n. 6, p.1632–1637, 2017.
- [4] OGATA, K. **Discrete-time control systems**. [S.l.]: Prentice Hall Englewood Cliffs, NJ, v. 2. 1995.
- [5] DORF, R. C.; BISHOP, R. H. **Modern control systems**. Pearson (Addison-Wesley), 1998.
- [6] BABU, V. M.; DAS, K.; KUMAR, S. Designing of self tuning pid controller for ardronequadrotor. In: IEEE. **2017 18th international conference on advanced robotics (ICAR)**. [S.l.], p. 167–172. 2017.
- [7] ASTRÖM, K. J.; MURRAY, R. M. **Feedback systems: an introduction for scientists and engineers**. [S.l.]: Princeton university press, 2010.
- [8] PRAKOSA, J. A.; SAMOKHVALOV, D. V.; PONCE, G. R.; AL-MAHTURI, F. S. Speed control of brushless dc motor for quad copter drone ground test. In: IEEE. **2019 IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering (EIConRus)**. [S.l.], p. 644–648. 2019.
- [9] DEVOS, A.; EBEID, E.; MANOONPONG, P. Development of autonomous drones for adaptive obstacle avoidance in real world environments. In: IEEE. **2018 21st Euromicro Conference on Digital System Design (DSD)**. [S.l.], p. 707–710. 2018.
- [10] YANG, J.-h.; BI, X.-y. High-precision temperature control system based on pid algorithm. In: IEEE. **2010 International Conference on Computer Application and System Modeling (ICCASM 2010)**. [S.l.], v. 12, p. V12–568. 2010.
- [11] NOVATEL (Brasil). **Attitude - Pitch/Roll/Yaw**. 2019. Disponível em: <<https://www.novatel.com/solutions/attitude/>>. Acesso em: 25 mar. 2019.
- [12] CARLOS, B. B.; OLIVEIRA, P.; SA, R. C.; RODRIGUES, W.; ALEXANDRIA, A. **Desenvolvimento, metodologia de testes e simulação de um quadrotor**. In: . [S.l.: s.n.], 2015.
- [13] BAERVELDT, A.-J.; KLANG, R. A low-cost and low-weight attitude estimation system for an autonomous helicopter. In: IEEE. **Proceedings of IEEE International Conference on Intelligent Engineering Systems**. [S.l.], p. 391–395. 1997.

Reducing Defective Indexes in the Printing Process of the Computer Plates with the Application of the Welding Paste

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Abstract— *The process of automatic assembly of the smaller components in the plate making industries represents an important manufacturing activity that influences all stages of production. Thus, it is necessary that from the beginning of this process there is a technical follow-up regarding the development of the assembly of the computer boards. The most important process in the manufacture of these plates is the welding process, where 70% of the defects occur, are found from the application of weld. In order to minimize the defects that occurred in the process phase called SMT (Surface Mount Technology) a study was made on the most frequent defects within this process with the use of 5W2H tools and the Ishikawa Diagram. Thus, the project aims to reduce defect rates in order to extend product life and continuous improvement in the automatic assembly process of smaller components.*

Keywords— *Welding Process; Surface Mount Technology; Solder Paste.*

I. INTRODUCTION

The present study was developed in a national company of manufacturing of computer boards of Polo Industrial of Manaus, supplier of service of electronic manufacture. One of its main macro processes is the SMT (Surface Mount Technology) where the automatic assembly process of the smaller components is done, its main phase is called "Solder Paste Printing".

The printer equipment is responsible for printing the solder paste on the PCB (printed circuit board) using the process tools called Stencil and Squeegee, which are the main tools for solder paste printing. Stencil, which is a perforated metal mask according to the PCB layout, and Squeegee is a squeegee blade that rolls the solder paste through the stencil hole, this process occurs only after the plate enters the Printer machine by the conveyor and is read from the fiducial, after confirmation, the clamp attaches and raises the plate through a base or backpupin to the stencil, completing the printing process the PCB is ejected.

Companies certified in ISO 9001, seek the continuous improvement of their processes and manufacturing systems. The project aims to reduce the rate of defects from this phase.

The research project brings continuous improvement in the SMT process by working on the high defect index,

such as: Solder Paste Failure, Solder Short, Solderbooll, Displaced, Tombtorning, among others. Knowledge in the automatic assembly process increases productivity by directly associating the efficiency of a production process to the generation of a product with a certain degree of reliability, bringing satisfaction to customers with the quality of their product obtained in the process, and increasing the profitability of enterprises.

The question to be answered in the light of this study is: What improvements are needed in the plate printing process that reduce defect rates?

Thus, at the end of this study, it is intended to optimize the automatic assembly process by making an analysis to identify the possible defects given in the printing of the solder paste so that a plan of action is planned and to implant the continuous improvement within the process.

II. THEORETICAL FOUNDATION

In the studies carried out, the SMT process is present, which explains the process steps that are divided between printing, inspection, injection of components and re-fusing. The process of preparing the solder paste which is addressed on: the pulp used in the process and the procedures performed in the preparation of the solder

paste. Welding process that refers to the application of the paste and to the time of refolding.

2.1 Detail of the SMT Process

The development of technology in recent years has enabled the use of equipment, techniques and compact products, which only existed theoretically, in the same it was possible to believe that they could exist in the insertion of physically ultraminiaturized components and even pop technology the assembly process SMT as a consequence of the advanced technology, had to be improved in the changes of the processes industries, such as equipment renovation, retrofit, programming techniques and optimization in a production line to meet the market demand of plates (Cellular, Tablet, Ultra book, HD, SSD, PDA).

It is presented by [1] an automatic optical inspection system based on neural network for the diagnosis of defects of solder joints in printed circuit boards assembled in surface mount technology. In his book [2] he discusses the theories and application of SMT and states that this is a technology of the day-day and not of the future. Optical surface assembly technology (O-SMT) was introduced, which was proposed by [3] to provide a possible solution to serious growing problems in the manufacturing process of optoelectronic products. After discussing the basic idea of O-SMT, the experimental results are also described to show its viability.

According to [4], Machine through a wave of liquid solder that runs through the lower surface of the printed circuit. In SMT technology, component insertion machines, chip placer and large placer are commonly used throughout the production process, from the application of the solder paste to the assembly of the components and the reflow of the solder paste, since the components in general are very small, sensitive and require great assembly precision, requiring very strict control of the process parameters.

This SMT technology is what makes use of SMD components (Surface Mounting Device), which was created to provide the assembly of electronic circuitry using automatic machines or fully automated assembly lines. In the SMT process where the printing process is done, inspection, automatic assembly of the electronic components and reflow. According to [5], the SMT process begins by the step of printing the solder paste, which is one of the phases corresponding to 70% of most defects becoming the most critical process.

The printer equipment is responsible for printing the solder paste on the PCB using the process tools called Stencil and Squeegee, which are the main tools for solder paste printing. Stencil, which is a perforated metal mask

according to the PCB layout, and Squeegee is a squeegee blade that rolls the solder paste through the stencil hole, this process occurs only after the plate enters the Printer machine by the conveyor and is read from the fiducial, after confirmation, the clamp attaches and raises the plate through a base or backpupin to the stencil, completing the printing process the PCB is ejected for the automatic insertion process .

According to [5], inspection equipment and reflow ovens are subject to maintenance actions given their importance to the process. However, pick-and-place machines are the most complex and have the greatest potential at the same time to introduce and suffer process failures. The automatic insertion process, where the SMD components are placed on the surface of the PCBs extremely fast and with impressive precision and that give us the guarantee that the components are glued in a form centralized, with minimal losses and a good productivity. This process corresponds to 20% of the defects that occur within the assembly sector, since the risk that the automatic insertion machine corresponds to the removal of the components of their cocoons (a coil, tray, blister) and to position on the surface of the PCB.

The reflow process is what corresponds to 10% defects in the SMT process, where the welding of the terminals of the components with the PADs occurs. However, when it comes out of the automatic insertion the component terminals are only leaning against the solder paste, because the melting furnace is what guarantees the weldability and has the capacity to reach the temperature capable of melting the solder paste properly and making the connection between the pcb and the components.

2.2 Solder Paste Used in the Process

In the process of manufacturing computer boards, lead-free solder paste is used to avoid contamination in the environment, according to [5], previously used soldering (tin-lead alloys or Sn-Pb alloys) provided auto alignment and corrected minor component positioning errors during re-melt, a property that lead-free solder does not have, but lead-free solder paste is known for the effect of not causing health damage and to the environment.

According to [6], welded joints can be as strong as the base materials if an addition metal has higher strength properties than these materials and if welding techniques are used appropriately. In a welding process, if the material to be used is of good quality, resistance can be adequately formed.

This process is quite complex since the beginning it is essential that since the project planning, you have to think about what type of solder paste should be used in the

SMT process, as this can directly affect the productivity and the quality of the product.

According to [7], in a welding project the most basic orientation is that the product needs to be designed from the outset as a welded joint, not as a cast or forged or otherwise shaped joint. In this way the most appropriate process to be worked is welding.

2.3 Welding Paste Preparation Process - SMT

According to [8], welding procedure qualifications and welder (or operator) are part of the quality assurance system in welding. The preparation of the solder paste is a necessary procedure for the production process. Solder paste pots are stored in freezers at a temperature of 0 ° C to 10 ° C. For the use of the solder paste in production, some MIX (OKTEK G-5000A) MIX process and rest procedures must be followed. soldering.

After removing the solder paste from the freezer it is necessary to place it in the cabinet for the rest of the solder paste in the period of two hours. After removing the solder paste from the cabinet it is necessary for the operator to tap using the MIX equipment (OKTEK G-5000A), which makes the rotary movement for one minute to activate the flow containing the solder paste making it more homogeneous.

To perform the resting process in order to comply with the technical specifications of the solder paste. Production can only use the solder paste if it is rested for 2 hours at room temperature.

III. MATERIALS AND METHODS

The studies conducted within the SMT sector, with the divisions of each process, were effective as they helped to understand the capacity of each machine and which materials were suitable for the in-process use. Thus, it became easier to analyze the machines and materials, thus bringing the evidence of where the high defect rates occurred and implementing possible solutions within the process.

3.1 SMT Process Analysis

In the process of printing the solder paste the sample of the high defect index inside the process was carried out as in figure 1 below.

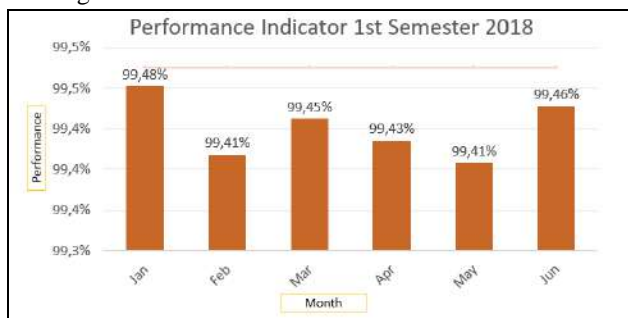


Fig. 1: Performance Indicator 1st Semester 2018

The performance of the process in January was 99.48% the highest index, in February there was a drop to 99.41%, in March it was 99.45%, in April it dropped to 99.43%, March it dropped more to 99, 41% in June there was improvement to 99.46%.

Figure 2 shows the behavior of the process performance through Pareto Diagram.

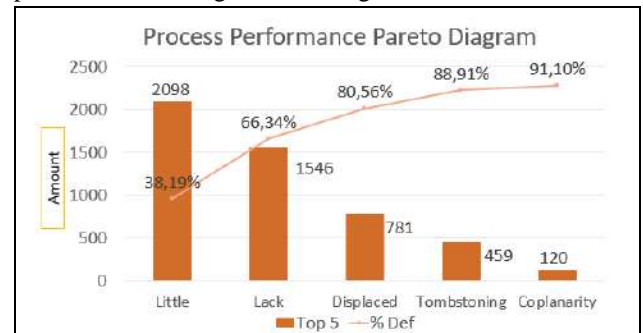


Fig. 2: Process Performance Pareto Diagram

In the process of the SMT, the problem in the weldability of the board was found, in which they reflected as: insufficiency of the solder paste, short of solder, solderball, displaced, tombstoning and among others, in Figure 3, the Ishikawa Diagram was performed to analyze the cause of the problem in the printing process of the solder paste.

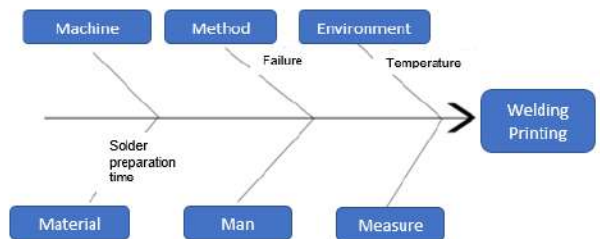


Fig. 3: Analyse Process Ishikawa Diagram

For the better elaboration and understanding of the failure scenarios, there are several analysis tools available, one of which, the cause-consequence diagram, according [9]. This diagram is a graphical analysis that lists the sequence, from a known initial event, that leads to a set of consequences, through a specific syntax, according [5].

The diagram shows that the root cause of the problem is directed to the process of preparing the solder paste, from the beginning of the phases to the last phase of the SMT process.

3.2 Problem Encountered in the Process

In the SMT process, the problem in the weldability of the board was found, in which they reflected as:

insufficiency of the solder paste, short of solder, solderball, displaced, tombstoning and among others, which refers to the process of preparation of the solder paste. Before the process of resting the solder paste was controlled by labels that were adhered in the pot of solder paste where the date and time that was withdrawn from the freezer was placed, since they were stored in a plastic container with three drawers where stored separately each model of solder paste.

The problem found in this container is that there was no control that ensured that the solder paste was rested for a time determined by the technician. For the operator of the printer machine had the freedom to withdraw the solder paste at the moment when it found necessary to be beaten in the equipment OKTEK G-5000A for five minutes because it was out of technical specifications, rest time of the solder paste, causing the defect index to be higher than the average.

3.3 Materials Used in the Project

To start with the project it was necessary to divide it into four parts that were identified as follows: 1st Structure construction, 2nd Mechanics, 3rd Electrical, 4th Sonoff device configuration. Both were essential and representative parts within the project, so that it was accomplished obtained the need for the following materials:

1. Power supply 60w, 100-240vac, 24vdc, 2.5a;
2. Timer in solid state;
3. Din rail socket p / my2, c / prot.p / finger, black;
4. Solenoid directional valve - sy5240-3dz series;
5. Manifold sub-base;
6. 1/8 silencer;
7. Straight brass instant connection;
8. Compact-series pneumatic actuator cq2;
9. Aux valve. Of flow control - as series;
10. Magnetic sensor;
11. Regulator filter - aw-b series;
12. Straight brass instant connection;
13. Polyurethane tube;

IV. IMPLEMENTATION OF PROCESS IMPROVEMENT

According to the studies carried out in the process were identified the most frequent defects within the SMT sector, in which it leads the index of defects much higher than expected, for which it was diagnosed in the prince of pcb that were studied, and identified that the problem was not in the printer and on the plate, new studies were carried out, to which the solder paste was involved, that the most frequent defects were identified.

The process of preparation of the solder paste was found problem in which all phases of the SMT influence, causing the defect index to be high, for this a corrective action plan was carried out using the 5W2H quality tool in the table 1.

Table.1: 5w2h Action Plan

Why Hould we Follow the Technical Specifications of the Supplier?			
WHAT	HOW	WHO	WHERE
Reduce defects in the SMT process caused by the printing of the solder paste;	Elaborating an automatic cabinet for the correct rest of the solder paste;	Technical and engineering;	Process for preparing the solder paste;
WHEN	HOW MUCH	Status	
8 Mounth	\$ 1.430,20	Project is under test	

In order for the soldering process to be corrected, a corrective action plan was implemented in which it corresponds to the design of an automatic cabinet that monitors the rest time of the solder paste. The steps in the implementation of the automatic closet design were as follows:

1° Construction of the structure:

A - Assembly of the cabinet structure with profiles and aluminum plates;

B - Mounting in the structure of the angle and partition in MDF;

C - Assembly of the walls of the cabinet structure, sides and bottom in acrylic;

D - Mounting the doors in acrylic.

2 °Mechanics:

A- Installation of the mini electric locks 12V solenoid in the aluminum frame.

3 ° Electrical:

A- Connection of Sonoffs, transformers and electrical locks.

4 ° Sonoff device configuration:

A - Creation of activation and deactivation schedules.

4.1 System Automation

The device control system will be managed through a main HMI, 4.3 "(inches), where it will be possible to lock the selected drawer. After the drawer is locked, in normal process, the opening will only be released again after the 2 (two) hours, pre-established, has been completed.

In case of unforeseen circumstances, the drawer can be unlocked by the HMI through a password and login, provided to system administrators. Another possibility would be if there were any emergency situation and it was necessary to unlock all the drawers immediately, just press the emergency button found on the front of the device. However, in this situation, it is only possible to restart the process with the administrator release through the HMI. The information shown on the HMI will be:

- Status of each drawer (indicating whether the drawer is locked or not);
- Indication of elapsed time of rest per drawer;
- Process start and stop button;
- Display with fault indication and events;
- Access control for system administrators;
- Stand-by time setup screen per drawer.

4.2 Mechanical Construction of the Device

The coating of the device will be 2 (two) materials, polycarbonate and MDF, both with thickness of 12mm. Drawer latches will be performed by pneumatic actuators that are installed in the back of each drawer. The drawers have on the front of the polycarbonate material, so you can see the internal contents of the cabinet when closed. The rails of the drawers will be of the telescopic type. Each drawer will have a subdivision of 4 (four) compartments.

4.3 Installation in Process

The device will be taken to the previously tested installation location. However, the final test will not be discarded against the customer who took the service. The contractor must provide at the place of installation an electrical supply point 220Vac 1F + N + PE or 127Vac 1F + N + PE together with pneumatic power point for the cylinders of the device.

In order for the assembly procedures of the automatic cabinet to be carried out correctly, it was necessary to make available to the technical workforce for the construction of the device: a Technician in Industrial Automation, a Technician in Industrial Mechanics and a Mechanical Assistant. Each technician has the specialty in the area that will work so that the project does not establish errors in the execution.

Thus, this project reflects on a schedule to open only in a given time by the technician that was long enough for the folder can rest and be directed to the process. The corrective action was taken based on the schedule that corresponds to the project developed and implemented internally in the manufacturing area of the Industry.

V. DATA ANALYSIS

Based on the demonstrated studies, the defect index found within the process was well above the expected, but were found defects in the weldability of the plate, such as: insufficiency of the solder paste, short Solder, Solderbooll, Displaced, Tombtoring, among others . According to figure 4, it was possible to analyze the percentage of defects within the process of weldability of the plate to each month, considering the relation between

minimum, maximum, the target and the reality of the quality standard in the process .

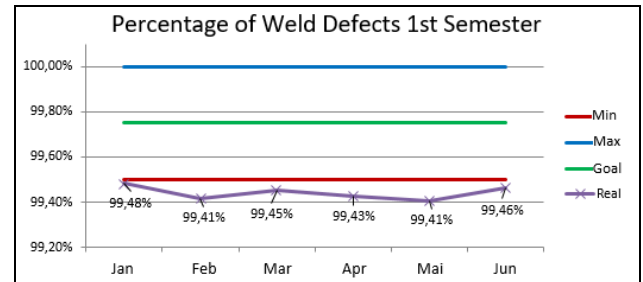


Fig. 4: Percentage of Weld Defects 1st Semester

Based on the analysis carried out between January and June, the company's quality standards targets were highlighted, which were below the minimum level, which however is detrimental to the process and to the clients, although it has studied the process and has diagnosed the root cause of the defects were deployed in the process improvements at low costs.

After having done the process defects analysis, and have found the possible solutions for continuous improvement. Adjustments were made within the process and the actual level of the quality standard was diagnosed, which were positive results for the company. In the month of July to December, shown in figure 4, the level of quality standard were highlighted from 99.43% to 99.85%, since the target of 99.75% were successfully achieved. In addition to the target reached obtained a cost reduction of R \$ 37,458.00 which is of great importance to the company.

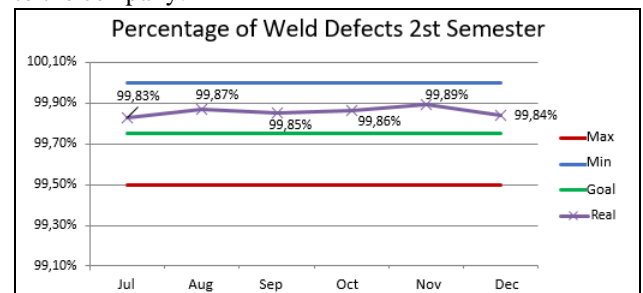


Fig. 5: Percentage of Weld Defects 1st Semester

The process improvements were effective for the company as it obtained results such as cost reduction and the percentage of defects well below those of the previous six months. Because the adjustments within the process were made through the company's technicians without the precision of outsourced companies.

VI. CONCLUSION

When investigating the causes of major defects in the printing process of the computer board it was identified that the resting process of the solder paste was controlled

through the labels that were adhered to the solder paste jar where the date and time that was placed removed from the freezer because they were stored in a plastic container with three drawers where each model of solder paste was stored separately.

The problem encountered in this vessel through the analyzes performed within the process of preparing the solder paste was that there was no control which ensured that the solder paste was rested for a time determined by the technician. For the operator of the printer machine had the freedom to withdraw the solder paste at the moment when it found necessary to be beaten in the equipment OKTEK G-5000A for five minutes because it was out of technical specifications, rest time of the solder paste, causing the defect index to be higher than the average.

Based on the analysis performed, a corrective action plan was proposed and planned, which consisted in the idea of the realization of an automatic cabinet with locks and timer, in which the guarantee is made that the solder paste will be adequately rested. Based on the studies, the project was implemented and analyzed.

With this design of the Automatic Closet had the reduction of number of defects well above expected because the application of the correct procedures before the solder paste go to the process, influence on the index of defects, because the solder paste being rested for a while determined at room temperature and then tapped into the OKTEK G-5000A equipment following the technical specifications, this activates the flow containing the solder paste, leaving it more homogeneous and ensuring that it will not cause future problems inside the production, as this will reach the quality within the process.

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REFERENCES

- [1] ACCIANI, Giuseppe; BRUNETTI, Gioacchino; FORNARELLI, Girolamo. Application of neural networks in optical inspection and classification of solder joints in surface mount technology. IEEE Transactions on industrial informatics, v. 2, n. 3, p. 200-209, 2006.
- [2] PRASAD, Ray. Surface mount technology: principles and practice. Springer Science & Business Media, 2013.

- [3] UCHIDA, Teiji; MIKAMI, Osamu. Optical surface mount technology. IEICE transactions on electronics, v. 80, n. 1, p. 81-87, 1997.
- [4] MORAES, André Luis. Otimização do Processo Produtivo de Montagem de Placas SMT. Faculdade de Jaguariúna. Jaguariúna, 2006.
- [5] CARDOSO, Idélcio Alexandre Palheta; SOUZA, Gilberto Francisco; TOMYAMA, Domingos. Elaboração de estratégias de manutenção para linha de produção operando novos conceitos em SMD. CIBIM 8, 2007.
- [6] GROOVER, Mikell P. Introdução aos processos de fabricação. Grupo Gen-LTC, 2000.
- [7] KIMINAMI, Claudio Shyinti; DE CASTRO, Walman Benício; DE OLIVEIRA, Marcelo Falcão. Introdução aos processos de fabricação de produtos metálicos. Editora Blucher, 2013.
- [8] MODENESI, Paulo J. Normas e Qualificação em soldagem. 2000.
- [9] VIEIRA, Sonia. Estatística para a Qualidade. Elsevier Brasil, 2016.

Application of Black Oxidation in Carbon Steel Parts in a Tool Company

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Abstract— *The project of implantation and application of the process of black oxidation, in a tooling company, has the objective to improve an improvement in the assembly processes and the machined parts, to reduce the adjustment and finishing time of some of the services performed in the tool shops, resources were applied through an implanted sector to carry out such operations. The elaboration of this project was based on the identification of the problem, which caused delays and excessive expenses due to the logistics of the process that was done outside the industrial center of Manaus, through the methodology of the PDCA, the implemented process, was applied in practice, executing the mounting on the two-pole pole devices, with the machined parts, having the logistics time for 7 days on average, and from now on with the deployment, is done in a few hours, reducing time and costs, and better serving customers that request the services in shorter term, cost and benefit.*

Keywords— *Black Oxidation, PDCA, Process and Assembly.*

I. INTRODUCTION

With the great competitiveness in the labor market, and the growth of machined parts of various types and sizes, the organizations are adapting themselves, and specializing to keep their customers, in the face of the possibilities companies, seek to apply the black oxidation method, for different reasons. Assigning upgrades, and optimizing final assembly time, one of the problems encountered is the ready-made parts waiting to form a batch, to be able to perform its external service, from the moment the parts are finished and are not sent for black oxidation, they are subjected to corrosion and rust due to the waiting time for shipping, and many times the material needs to be transferred in a machine. Black oxidation is used to maintain the appearance of the parts, improve product aesthetics, and extend durability due to the protective layer that is made in the process. The most common finishes are: Chrome plating, nitriding, zinc plating, anodizing and black oxidation.

The surface coating of the machined parts consists of a set of methods that aim to improve the shape and characteristics of the object without significantly modifying the geometric configurations of the object, which must be precise so that there is no damage to the functionality of the product. It provides a much better presentation to the parts as well as certain weather resistance to which they can be exposed.

Black oxidation is a surface coating that consists of a film applied to the metal surfaces and minimizes contact of the substrate with corrosive agents, in order to minimize the wear of the product by the action of the medium.

The type of coating applied will define the protection time it will exert in the material, the ability of adhesion, its thickness or even permeability and the passage of undesired agents through the coating film.

It is possible to increase the corrosion resistance of black oxidized material through the use of a coating such as oil, varnish or wax, and the wax may alter the color of the material, but it guarantees the best protection.

II. THEORETICAL FOUNDATION

Corrosion is a phenomenon that occurs with all materials regardless of their nature [1]. Even the wood undergoes corrosion when it enters a state of decomposition, that is, biological degradation. In the polymers (pvc, teflon, plastics and etc.), corrosion develops through the action of weather (weathering) and chemicals.

The corrosion processes in steel according to [2] are: galvanic, occluded cell corrosion, corrosion under stress, corrosion-erosion, corrosion fatigue, atmospheric corrosion, microbiological corrosion and in other special cases corrosion by hydrogen.

Oxidation, the most common chemical process in corrosion, compromises the mechanical structure of steel, which can bring financial and even irreparable damage as loss of life. Corrosion in the metal must be eliminated or reduced to the maximum its action given the possible damages caused by it. Among the most common methods of protecting the metal surface are: Cathodic Protection, anodic protection, change of corrosive medium (substance that inhibits the chemical action of corrosion), metal change (corrosion resistant special construction materials) and protective coatings (non-metallic, non-metallic, inorganic, metallic or protective oxides as a consequence of the oxidation of the metal itself) to ensure the corrosion resistance and the mechanical properties of the steel (the type and process of the coating depends on the application of the steel). As can be concluded, the mechanisms of corrosion are different for each material and may be chemical, biochemical or physical.

2.1 Ferrous Metal

In ferrous metal, corrosion is much more known and studied because its action is easily perceived, as we can see in figure 1, and it is present in daily life among people, as in other materials it occurs by chemical, biochemical and physical [4]. The combination of these factors can further accelerate or slow down the process. When we talk about corrosion, we are referring to the deterioration of a specific material or product, particularly metallic, by chemical or electrochemical action, being of the medium in which it is inserted, related in its mechanical stresses [5]. The deterioration caused by the physical-chemical interaction ends up causing damage and wear to the material, and between its operational environment, attributing the wear on the parts, which implies in the use that becomes inadequate.

2.2 Corrosion

Corrosion assigns direct failure of metals when in service render them susceptible to rupture by some other mechanism [6].

Metal corrosion is the transformation of a metallic material or alloy by its chemical or electrochemical interaction in a given exposure medium, a process that results in the formation of corrosion products and the release of energy. An example of corrosion can be seen in Figure 1.



Fig. 1: Corrosion in polymer caused by the action of chemicals [3].

With the great use of mainly ferrous metal alloys which have low manufacturing value and high mechanical strength properties, compared to other metals, the problem of corrosion has arisen because iron is easily oxidized. Due to the predominant chemical element in the composition of the steels, the iron is perceived in the ores, obtaining forms of oxides, and in the metallurgical is extracted.

This transformation leaves the material thermodynamically unstable. Corrosion, therefore, is nothing more than the return of the metal to its more stable state, that of natural oxide [7].

2.3 Black Oxidation

Black oxidation is a type of coating through a chemical treatment, it can be called blackening or blackening, which guarantees a good resistance to corrosion. The black oxidation, gives the treated parts resistance to corrosive wear during storage, as well as a low risk of contamination, figure 2.

The black oxidation process is used, among other applications in: firearm parts, cutting tools, components and blocks of hydraulic machines, chains, gears, screws, hand tools, valve bodies and automotive components [7].

Black oxidation can be achieved by thermal or chemical processes. In thermal processes, the coating is obtained by heating the workpiece at about 480 ° C, causing the surface of the workpiece to react with atmospheric air to the formation of black oxide (magnetite). The part is cooled to ambient and oiled air. The heating of the parts is usually carried out in ovens [8].

This process has a degree of imprecision associated with the difficulty of distributing the heat load in the furnace and has a high cost with energy. In chemical processes the parts are dipped into various chemical solutions that produce an oxide film in the product.

Black oxidation through a chemical process can be carried out either hot or cold. The so-called cold black oxidation is performed at room temperature, obtained through baths in liquid alkali solutions diluted in water,

where chemical reactions produce a uniform black film in the pieces dipped in the baths. This process is used for cast iron and steel parts with chromium content less than 12% [7].

The hot process uses caustic solutions, and under the action of temperatures between 135 ° C and 140 ° C form a black layer of ferrous oxide on the surface of the parts. Also recommended for steel parts with a chromium content of less than 12% this process is more advantageous in relation to the cold process by the reaction speed and lower cost with chemicals.

It is suitable for surface steel, stainless steel, copper, brass and tin. Its characteristics and properties become ideal for certain applications, making it a benefit as it protects the metal from further corrosion.



Fig. 2: Parts after layer conversion (black oxidation)[9].

The brightness of the oxidation film, depends on the state of the surface of the part, when the part is polished, the surface would produce shiny black films in the parts. The product formed on the metal surface treated by black oxidation, is an iron oxide, among the several that can form, known as magnetite.

III. TOOLS AND METHODS

The exploratory research allowed to establish opportunities for improvement in the market in the face of the adverse reality of the process then employed, for which the PDCA was used, which means: Plan, Do, Control and Act.

The PDCA cycle according to [10] is considered as an innovative management system, with fundamental principles in the applications, besides corrective actions, the method stimulates the improvement of processes and products.

It is a tool based on repetitions and successively in processes [11], seeking continuous improvement. To plan is to establish the necessary objectives and processes; developing is implementing the plan and executing the process; to check is to measure the data collected; act is to take corrective action and determine where to apply for change.

3.1 Characterization of the Oxidation Problem

For the identification of the problem and conclusive solution was used the comparative logic that advocates the before and after analyzes. Analyzes of pre and post project data were performed both quantitatively and qualitatively, focusing on increasing productivity in the manufacturing of parts and reducing cost while maintaining product quality.

The need for such coatings is justified by the fact that the making of a device takes a certain amount of time, because assemblies and adjustments of the mechanisms thereof are carried out according to the tolerances of the designs, and since most of the parts of the devices are made of steel the carbon was subject to very rapid oxidation. For most cases the protection of the metal surface of manufactured devices could be provided by painting or chromatization.

3.2 Problem Analysis Tools

The research criteria were those recommended by the bibliographical and experimental research, where the coating processes of the materials used in a tooling industry were investigated for the needs to be supplied, pointing to the application of black oxidation. For the background of work and research, the history of the process used before any change was raised. Data were collected before, during and after performance improvement.

Based on the PDCA cycle methods, difficulties were identified in relation to the logistics of the previously executed process, with the implementation performed the following steps were taken;

- Define the problem;
- Identify the possible causes;
- Check the actual causes;
- Propose a solution to the problem;
- Deploy the solution;
- Analyze the results.

3.3 Solution Method

The surface coating process known as hot black oxidation, which is used by several PIM companies, aims to improve product aesthetics and prevent corrosion without affecting the functionality of the devices and tools. This type of coating has gauge thickness; very small compared to the dimensional of the pieces. Therefore it is said that black oxidation does not alter the dimensional of the tools.

The parts sold in a company of the tooling branch, are obtained through the processes of machining, lathe, milling, grinding and CNC. The steel is machined according to a predefined design (mechanical drawing). In the mechanical drawing are defined the geometries and

profiles according to each function of the item to be constructed.

The technological problem arises when parts and devices need some form of coating; Causes for such a coating are, among others, aesthetics and protection. Many are the possibilities of building this coating, but due to the search for better performance and reduction of resources employed the problem is to find the best coating (from a quality point of view) that generates less costs. The costs of the process are included: logistics, waste disposal, hiring of labor, effluent treatment, thermal energy and production time.

The most crucial factor in choosing a coating for the devices and tools manufactured by the organization is that it can not change in a significant way the dimensional required in the mechanical design of the product. If this occurs, the item may partially or completely lose its functionality and lead to customer dissatisfaction. By way of example only, suppose a paint layer with a thickness tolerance of $\pm 10 \mu\text{m}$ was applied to a layer of paint by means of high pressure paint guns. The paint has a reasonable cost (neither so expensive nor so cheap) compared to other coatings, it has excellent aesthetic finish and gives one of the best possible protection to the metal surface. The only problem with the use of paints is that the minimum aggregate thickness of the paint, using the high-pressure paint method, is $12 \mu\text{m}$, which is already greater than the tolerance. Using paint to protect this tool could severely impair the functionality of the tool.

Therefore, there is always a binomial to consider, productivity and cost, linked to the implicit and inherent constraint of the process, the low dimensional change.

IV. IMPLEMENTATION

The implementation of the black oxidation process demands the verification of several factors: quantity of parts, volume of parts, Individual Protection Equipment (EPI's) of the employees who handled the chemical solutions, the geographic location of the sector in front of the industrial plant, the tanks for preservation of the solutions, the need for conveyors, use of thermometers, stainless steel containers for immersion in the heated solution, adoption of gas or electric resistance heaters, use of caustic soldering, use of paint stripper and selection of the appropriate degreaser.

The guarantee of a good finish in the black oxidation process is due to some parameters that must be rigorously maintained. Among the many factors that ensure a good quality of the formation of the conversion layer are: the initial state of the parts, the degreasing, the pickling, the

immersion solutions and the temporary coating process of the parts with oil.

Special care should be taken with the handling of the pieces during the black oxidation process, as the uric acid present in the sweat reacts at the moment of cooling of the parts in which the layer was applied.

It has great relevance to the process the chemical composition of the materials on which it is desired that there is deposition of the black oxidation, since the conditioning or differences between materials (finishing machining, tempering, welding, among others) can interfere in the form, in the time, in the tonality or even in the black oxidation itself, not obtaining the same results of the processes due to the variation of some of these factors relative to the initial state of the part to receive the protection conferred by the process.

Contact with materials such as aluminum in the material that causes oxidation must still be considered and observed, as the contact of the aluminum with the black oxidation solution can cause small explosions in the black oxidation tank increasing the risk of accidents.

These explosions are caused by the release of energy (in the form of heat) in the reaction between caustic soda and aluminum.

Certain materials cause damage to the black oxidation process. One of the process steps is pickling. Cuprous materials in the paint stripper react with the solution by transferring the reddish hue that is characteristic to the other materials that are immersed in the pickling solution.

The solution does not change visually. Thus, a large quantity of parts can be contaminated by copper ions.

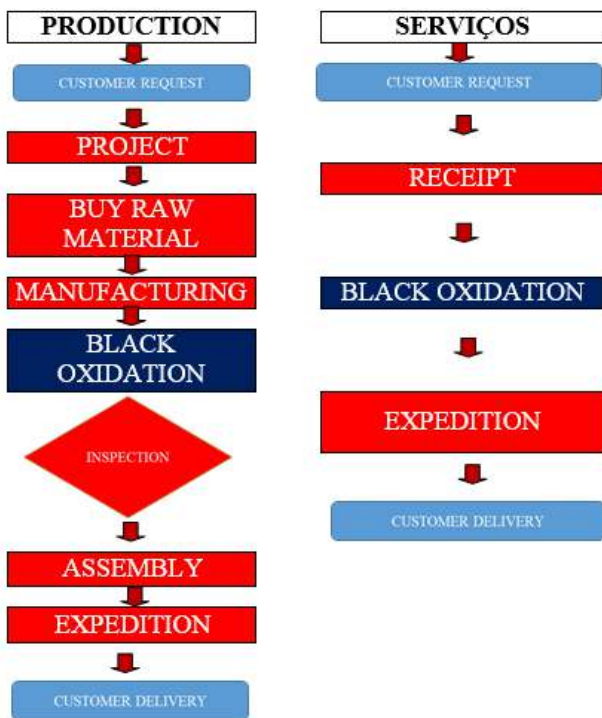


Fig. 3: Current flow of processes and services

4.1 Stages of Processes

Process 1- Selection of raw material

The raw material is separated and selected for thinning at the request of the final customer.



Fig. 4: Raw materials used in the manufacturing process

Process 2- Mechanical cleaning

This stage of the process aims to remove all dirt from the surface of the part, in the companies use: polishing, grinding, tumbling and blasting.

Process 3 - Detach

It aims to remove organic materials such as oils and greases through the solvent and organic baths or alkaline solutions, figure 5.



Fig. 5: Test piece being emerged in the container containing degreaser

Process 4- Rinse

Removes excess degreaser and debris from mechanical cleaning, figure 6.



Fig. 6: Test piece receiving rinse after the degreaser

Process 5- Stripping

A step in which rust and unwanted layers of oxidation are removed, leaving the surfaces of the parts clean and free from impurities and oxides. Acid pickling is the most common and economical, and was used in the experiment and implanted in the tool shop. The FERRUX-CL stripper was used.

4.2 FERRUX – CL

It is a hydrochloric acid compound that acts as a pickling agent for iron and high efficiency steel and contains corrosion inhibitors in a balanced way, allowing an inhibition of the attack of the acid solution on the steel. The tank containing FERRUX can be assembled as a solution containing 20% of the product or more, and may even contain the pure product. FERRUX reacts at room temperature and requires a reaction time between 10 and 20 minutes

Process 6- Rinse

Removes acidic particles and waste from the pickling stage.

Process 7 - Drying

Oxidation preliminary stage, carried out in an oven, made so that the oxide layer is homogeneous throughout the surface of the pieces.

Process 8 - Black Oxidation

The foregoing steps are a surface preparation of the parts for layer conversion known as black oxidation. In

this step the pieces are immersed in solutions appropriate to the determined temperature where they occur hot or cold reactions, for the formation of the iron oxide black. The product used in the experiment was RQ - OXID FE, which is a strongly alkaline product based on caustic soda, whose specific purpose is to oxidize iron, mainly in the metallurgical industry, tooling and the maintenance of weapons. The product consists of a solid maintained in aqueous solution at a concentration of 650g / l. To promote the process time between 10 and 20 minutes it is necessary to maintain the temperature between 135 ° C and 140 ° C, figure 7.



Fig. 7: Black oxidation test by RQ - OXID FE

Process 9 - Rinse 3 and Dry 2;

It aims to remove alkalis from the previous step, and prepare the surfaces of the parts for temporary additional protection.



Fig. 8: Enxague final após a oxidação negra

These are the steps presented in the process, then the results will be presented.

V. DATA ANALYSIS

Prior to the implementation of a black oxidation sector in the tooling company, outsourced service costs in the black oxidation process were R \$ 737.80 / month.

From the implantation of the sector in the company, positive cost / benefit results were obtained, table 1, and figure 9, where the monthly profit refers to the average of the first two months of operation.

Table 1 - Payback of the first month of operation of the black oxidation sector

	OUTPUTS	APPETIZER
INITIAL INVESTMENTS	R\$ 1.280,00	
FIXED COSTS	R\$ 890,00	
PROFIT OF THE FIRST MONTH		R\$ 12.662,00
SUPERAVIT (FIRST MONTH)	R\$ 10.492,00	

The organization began to generate profits in place of the previous dividends (expenses with outsourced services), because with the internment of the process of protection by layer conversion, in addition to meeting the internal needs, the black oxidation service became one of the differential services since this type of surface coating was not available in Manaus.

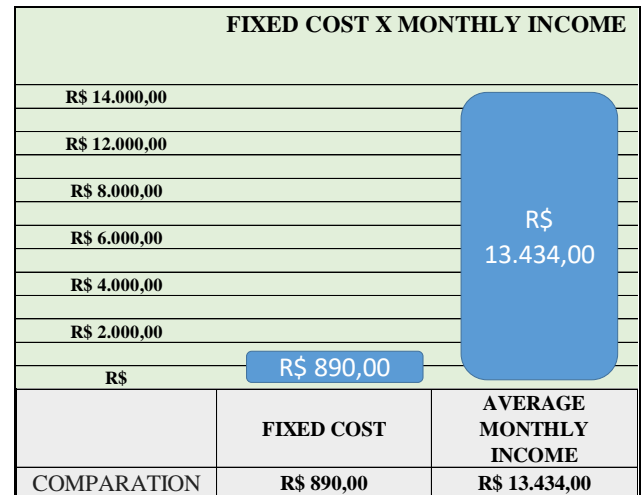


Fig. 9: Comparative Fixed Cost x Monthly Profit

The profits generated in the first month of operation of the sector paid all the investment made in the researches and adaptations of the area to assemble the whole structure for processing the pieces. In this way the production flow of parts that need black oxidation coating.

The relevant planning-based data that was run in the Black Oxidation deployment.

The post-finishing coating, which improves the level of corrosion protection after black oxidation. The protection is conferred by means of oil, wax or varnish; it acts against environmental contamination during transportation.

In the experiments that led to the implementation of the black oxidation sector, low carbon test specimens were used, which are the most used by the organization in its tool construction processes. Note in figure 10 the

photo before and after the black oxidation coating. The steels used were: H13, 1020, 4340 and VND.



Fig. 10: Before and after black oxidation - test pieces

The figure shows the comparison before and after the application of the black oxidation made in a test piece.



Fig. 11: Before and after black oxidation - Production

Figure 11 shows the process equation where the black oxidation is made in a test piece.

VI. FINAL CONSIDERATIONS

The application of the study was elaborated with the purpose of presenting the evolution of the process of experimentation and implantation of a black oxidation sector by immersion in the company, analyzing the options available in the market. Through the theoretical basis of some surface coating processes and their applications in the industry in general, the choice of the most adequate form of protection was made, tried and implemented with expressive positive results in the target organization of this project.

The resources available made possible the creation of higher quality products in a shorter period of time, as well as the provision of services previously provided by companies from other states. Another beneficial factor, besides the profit, of difficult measurement is that the process of black oxidation led the company to have a faster delivery of the customer's orders in relation to the others

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REFERENCES

- [1] JAMBO, Hermano Cezar Medaber; FÓFANO, Sócrates. Corrosão: fundamentos, monitoração e controle. Ciência Moderna, 2008.
- [2] FÓFANO, Sócrates; JAMBO, H. C. M. Corrosão: Fundamentos, Monitoração e Controle. Petrobras, Editora: Ciência Moderna, 2007.
- [3] PANNONI, F. DOMINGOS. Fundamentos da corrosão. Pintura Industrial, v. 48, n. 16, 2007.
- [4] FRAUCHES-SANTOS, Cristiane et al. A corrosão e os agentes anticorrosivos. Revista Virtual de Química, v. 6, n. 2, p. 293-309, 2013.
- [5] WOLYNEC, Stephan. Técnicas Eletroquímicas em Corrosão Vol. 49. Edusp, 2003.
- [6] CHIAVERINI, Vicente. Processos de fabricação e tratamento. vol. II,, 1986.
- [7] ZEMPULSKI, L. N.; ZEMPULSKI, MFS. Dossiê Técnico-Oxidação Negra. Serviço Brasileiro de Respostas Técnicas-SBRT, 2008.
- [8] CANABARRO, Felipe Ariel Furlan. Resistência à corrosão do aço inoxidável AISI 304 com implantação de íons de cobre. 2018.
- [9] DE ANDRADE VELOSO, Luana. Corantes e Pigmentos.
- [10] AGUIAR, Silvio. Integração das ferramentas da qualidade ao PDCA e ao programa seis sigma. Belo Horizonte: Editora de Desenvolvimento Gerencial, 2002.
- [11] FAVA, Rui. Educação 3.0: aplicando o PDCA nas instituições de ensino. São Paulo: Saraiva, p. 256, 2014.

Analysis of Failure Modes and Effects of the Process Applied to a White Line Industry

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Abstract— Increasingly, factories are forced to increase the reliability of their products and processes, since nonconformity generates poor quality and waste, interfering with competitiveness. In this way, the current scenario causes companies to seek out new methods to ensure robust process and product. One of the tools for continuous process improvement is Failure Mode Analysis and Effects (FMEA), which assists in the prior detection of failures in a given process, contributing to preventive action and problem correction in an efficient and agile way. This research intends to show the characteristics of the PFMEA in a case study, applied to the development of an assembly line of a mixed beverage machine. Finally, all analyzes and ideas addressed by a multifunctional team are presented through a standard PFMEA form, which allows the reduction of quality problems related to the product.

Keywords— Quality Management, Failure Modes and Process Effects Analysis (PFMEA), White Line Industry.

I. INTRODUCTION

Faced with a scenario where competitiveness becomes a crucial element for the growth of a company, and where customers demand increasingly complex and quality products, industries are subject to innovate the way their products are manufactured. For such innovations to be applied efficiently, they must be supported by tools that, with qualitative data translated into quantitative, are able to optimize the use and maintenance of these new means of production and indirectly improve the quality of the product.

Organizations that seek excellence in the process of failure management continually seek to reduce and eliminate the flaws inherent in their products and services [1]. A very expressive tool in this area is the Failure Mode Effect Analysis (FMEA) methodology, with proactive features that allow the identification and prevention of process failures. Thus, the more effectively this tool is applied, the more benefits it will bring to an organization.

This study was motivated by the high failure rate in the implantation of a beverage machine project in a white line industry. During the five years of production of the product, it was verified that the indicator of field failures increased continuously, reaching an index of 32%, motivating the use of Process FMEA, since it helps in the

search for continuous improvement, reduction of cost, elimination of failures and risks in the assembly, as well as in the increase of the reliability of the process. Thus, it is necessary to study this theme, since the previous design of the beverage machine in another manufacturing unit of the same group, had its quality indicators impacted and consequently its brand reached.

For this reason, the general objective of the research is to apply the FMEA quality tool to improve the reliability level of the beverage machine production process in a white line industry. As specific objectives, we must present concepts of quality tools, focusing on the analysis of failure modes and effects (FMEA); analyze the processes deployed, put to stand, in the production of beverage machines in a white line industry, to verify possible failures; and present needs to avoid flaws in the process.

II. THEORETICAL FOUNDATION

It is necessary to base the work focus from the existing theories on quality tools, especially in the PFMEA and its methodology, in order to base the subsequent analysis and interpretation of data collected in the field surveys, which occur specifically in the production of beverage machine in a white line industry.

2.1 QUALITY TOOLS

The industrial environment involves the production of tangible goods and, for this reason, Quality Management in this context focuses on the production process, with the objective of generating a product suitable for use. Thus, [2] lists some general characteristics of Quality Management in this environment:

Production and consumption are sharply separated;

The productive processes have precise information and are repeated several times. This makes them perfectly known, documented, and controllable. The bases for standardization and automation of many procedures are then generated;

Quality management is markedly marked by actions for improvements in the process, which involve efficiency and productivity at first, and effectiveness soon to follow. Hence, the elemental concept of quality in this environment is that of "absence of defects"; in fact, there is no way for a product to fit the intended purpose if it has some kind of defect;

The evaluation of process quality focuses on basic elements and points of control. The elements involve corrective, preventive and process consolidation procedures. The basic points are the critical situations or components of the process, well defined and characterized.

In this way, [3] argues that in modern companies, measures that promote quality constantly accompany products throughout their life cycle: the idea to serial production and delivery of products. Each phase of this process has its typical course and its sources of defects. In order to recognize these possible defects in all phases and to reduce them to a minimum, several tools were developed. Some of the main quality management tools are listed below, so that the next topic is specifically studied FMEA.

Flowcharts: according to [2], flowcharts are graphical representations of the phases that compose a process so as to simultaneously allow a global view of this process and, mainly, of the characteristics that make up each of the stages and how they relate each other. [3] explains that each step is represented as a rectangle and its subdivisions are represented as diamonds, in which the conditions of subdivision are written. Thus, [4] states that this tool also emphasizes the critical operations, which are understood here as those located at the intersection of several flows, identifying bottlenecks, in order to enable alternative schemes of action.

Pareto diagram: [5] explains that this structure migrated from the area of Economy to Quality Management by Juran. [6] clarifies that the principle says that, among many variables of influence, only few have dominant influence. I transport to quality management, which means that only a few defects cause the vast majority of defective parts (consequences of defects). In this way, [7] argues that it is more efficient to work in an organized way, allocating greater resources to elements that require them or are able to provide greater returns.

Histograms: According to [6], histograms are instruments widely used in Classical Statistics. Initially, they exemplify how a given situation can be described in a simple and efficient way; stimulate the use of images as basic elements of description of reality and induce people to use global views of processes to better understand them. In this way, its application has reflexes in the design and implementation of management processes.

Ishikawa diagram: Also known as a cause-effect diagram or a fishbone. [7] explains that its presentation scheme is similar to the spine of a fish: the main axis represents a flow of data and the spines characterize elements that converge for that fundamental flow. Thus, the main elements of the phase of the process under study and the elements that contribute to its formation are illustrated. This structure can be used to eliminate causes that negatively influence the process or to intensify elements that positively affect a set of operations.

2.2 PROCESS FAILURE MODES AND EFFECTS ANALYSIS (PFMEA)

The method of analysis and failure modes and effects (FMEA) was developed in the 1960s by NASA, United States, for aerospace projects, as explained [8]. In Germany it spread in manufacturing technology, especially in the automotive industry, in the second half of the 1980s.

The FMEA analysis is a tool that aims to avoid failures, be they process, product or design, by analyzing potential failures and by measures for improvement. Through its use, the chances of the product or process to fail during its operation diminish, increasing its reliability [9].

Although FMEA-like analyzes have always been conducted in manufacturing projects and processes, the first formal application of the FMEA was an innovation of the aerospace industry in the mid-1960s. Although initially designed to be applied to products and processes, due to its great utility, the FMEA methodology has been

applied in several areas, such as food and safety engineering [9].

In addition, the FMEA is one of the most efficient low-risk analyzes for prevention, identification and cost-effective solutions, and also shows great effectiveness when applied in a team effort. The application of FMEA, however, can generate expenses, but when executed efficiently it can result in a significant return of quality and reliability in the process or product where applied, reducing the cost of failure [10].

The application of the FMEA is based on previously planned meetings and the formation of small groups of people, who can identify their functions, the types of failures that may occur, the causes and the effects of these failures. All the information collected is applied in a table document that allows the evaluation of the results obtained. After this evaluation, the risk assessment of each failure through indexes is made, and based on the indexes found, improvement actions are discussed to be implemented in the process, and the necessary measures are taken to reduce the risks of the faults in question, increasing the reliability of the product or process [9]. To calculate the risk, the Severity (S), Occurrence (O) and detection (D) indices are defined for each cause of fault listed, in a range of 0 to 10. After defining the indexes, the risk priority is calculated (RPN), by multiplying the other three indexes, being demonstrated by the equation $RPN = S \times O \times D$.

The FMEA method contributes to the solution of the so-called structured problems, because through the implementation of this method, you get to know better the possible errors and failures due to the high detail of the process, which may cause problems, giving security to have this control to the manager, for the most effective treatment of these problems. This makes it easy to devise a plan to correct and avoid potential failures with a broader horizon in order to maximize results and minimize company problems.

2.3 PRODUCTION PROCESS OF BEVERAGE MACHINE IN WHITE LINE INDUSTRY

According to [11], industrialization is the socioeconomic process that aims to transform an initially retrograde area of society into a source of greater wealth and profit through the introduction of machines into productions. Consequently, this implies man's role in many tasks that were previously a production process. The process of industrialization led to the demographic situation in the regions where it occurred, leading to a great increase of great advances in industrial and

agricultural productivity and the rapid growth of the per capita income of the middle class and consumption pattern.

Times of industrialization are commonly divided into three and all fall into the same basic phenomenon. The eighteenth century marks the beginning of the Industrial Revolution or 1st Technological Revolution, which began in England. It was characterized by the invention of the steam engine and the consequent changes that had repercussions in the society by virtue of this new technology. Already the call The 2nd Industrial Revolution was marked by the discovery and use of electricity and use of oil as an energy source. Finally, the 3rd Industrial Revolution, also known as the Silicon Revolution, introduced the electronics and microelectronics industry into production assets.

In his work, [12] explains that large appliances such as refrigerators, freezers, stoves and washing machines belong to the white-line industrial segment. This type of industry has been present in the country since the late 1940s, a result of the policy of import substitution of durable consumer goods in force at the time. Since 1990, with the opening of the economy, changes in the Brazilian industrial structure have been taking place. In the first period, from 1990 to 1994, these changes were timid and limited to the increase in competition as a result of the entry of imported products into the market.

In the period after 1994, the stabilization of the currency and the partial recovery of the purchasing power of Brazilians stimulated more significant investments of foreign companies in the country. This phenomenon, as presented [13], is common to all national industry and represents the effects of productive globalization in Brazil, characterized by increasing foreign direct investment in the purchase of domestic companies, maneuvers known as takeover (when a foreign company takes control of a through the acquisition of its shareholding control).

Another way some national companies found to face competition was the formation of strategic alliances with international companies, essentially seeking training in new technologies as well as access to new markets.

2.3.1 Beverage Machine

According to [14], the inspiration for the creation of soft drinks came from naturally gaseous mineral waters. In the fourth century bc, the Greek Hippocrates, considered the father of medicine, already recommended baths in such sources, but apparently it never occurred to him to prescribe the liquid to drink. Carbonated water

only began to become a popular drink around 1500, when the Belgian town of Spa gained fame for its natural sources and began to export bottles of its water to London and other capitals. The success was so great that, between the seventeenth and eighteenth centuries, several European chemists began to make attempts to recreate the product artificially. The most important step was to adopt a pump to help fix the gas in the water, a finding credited to independent studies by Englishman Joseph Priestley and Frenchman Antoine Lavoisier between 1772 and 1773. Based on this system, pharmacist Thomas Henry became the first to produce industrial carbonated water in 1782.

A few decades later, the idea of adding flavors to the product came up: ginger would have been the first in about 1820, followed by lemon in the 1830s. This process was made easier by a new technology, patented in 1819 in the United States : soda fountain (or "soda fountain", as it is now called gaseous water), a pump installed at the pharmacy counters for the liquid to be carbonated on the spot, adding different flavors to the customer's taste.

Regarding the mixed drinks machine of the study in question, it is found that it was first produced in a factory located in Joinville, in the interior of Santa Catarina, in 2013. Since then, the product has gained strength and space in the market, it is a differentiated product. In terms of process, this product does not escape the idea of the other products produced in a white line industry, being divided into receiving inputs, product assembly, quality inspection, packaging and distribution.

III. METHODS AND TOOLS

The high failure rate of products on the field for a brand is usually quite damaging. Not having customer loyalty or trust in the product can become an irreversible cost to the company, since the end consumer should always feel satisfied with their acquisition.

The original Joinville mixed drink machine project had the indicator of final consumer residency failures at around 32%, according to data from the organization. The mission of the Manaus plant is to reduce this ratio by 17 percentage points in a year. One of the tools that can be used proactively to achieve this goal is the PFMEA, since it assists in the prior detection of failures, thus increasing the reliability and robustness of the product and process.

By completing the standard PFMEA spreadsheet, you determine the severity of the failure (how bad it will be if it happens), determine the occurrence of the failure (how often it actually occurs), and determine the probability of failure detection (how easy is to realize that it occurred).

As soon as the information is collected, the Risk Priority Number (RPN) is reached. This indicator is a way of knowing which mode of failure should be prioritized. This calculation is the multiplication of the occurrence, severity and detection values.

Once this is done, the Pareto Diagram is used to analyze which assembly lines where the RPN is greater than 80, thus establishing the actions that should be determined as critical, so that they are treated as priorities.

The investigation is characterized as a case study, since a case study was carried out, analyzing the production of a beverage machine in a white line industry and the application of the Failure Modes and Process Effects Analysis tool (PFMEA).

The research has a qualitative nature, as it analyzes the activities performed by the operators during the assembly of the beverage machine, and, from this survey, critically classifies them as to the criteria of severity, occurrence and detection of failures. It is also quantitative because it translates these criteria into numerical indicators to classify them according to levels of severity and importance. Therefore, it is characterized by a qualitative-quantitative research.

As for its purpose, it is a descriptive research, since the production process of beverage machines in a white line industry is studied, analyzed and observed for later application of the PFMEA tool, involving the use of observations and video records. A bibliographical research was carried out with the study of books and articles dealing with quality tools, especially the Analysis of Failure Modes and Process Effects (PFMEA).

Observations and video recording of the operators were carried out, in order to verify the activities related to the assembly of the product, for the collection of data done "locally" directly in the place where the problems are occurring, but it can not handle the variables, conceiving them as they are. The activities observed were as follows:

Station 10: assembly of the pump carrier;

Station 20: assembly of kits 1 to 5;

Station 30: assembly of kit 7 and main board;

Post 40: immold assembly and squeezer motor;

Test Station 1: test of hypot, CO₂, H₂N₂ and power test;

Test Station 2: functional test, performance test and water tightness.

Station 50: fairing and hipot assembly;

Robot station: robot test; interface board.

Test Station Flush: N2 and purge of water.

Post 60: product packaging.

IV. IMPLEMENTATION OF THE PFMEA

In the application of the selected method, all the functions related to the 10 assembly stations of the mixed drink machine were defined. They are: assembly of the pump support, assembly of kits 1 to 5, assembly of kit 7 and main plate, immold and squeezer motor assembly, hypot test, CO2, H2N2 and power test, functional test, performance test and water tightness, assembly of plastic parts and hipot, robot test; interface card, N2 and water purge and product packaging.

The data listed in figure 1 show the functions and mode of failure and effect that each causes in the process and in the final product.

Function / System Requirements (for DVP)	Potential Failure Mode	Potential Effects of Failure	Severity	Potential Cause Mechanisms of Failure	Occurrence
1. Lock Product on the Post	1. Do not brake	1. Pallet Beat	3	1.1 Wear	3
3. Passing the power cord	1. Misfit 2. Breaking Cable 1. Do not turn on 1. Break plastic lock	1. Noise 1. Do not turn on 1. Noise	3 3 3	1.1 Method 1.1 Method 1.1 Method	3 3 3

Fig. 1: Failure mode and effect of each process function

After defining the steps / identification of errors, the plot of the FMEA method was elaborated, as shown in the example in figure 2 below.

Severity	Potential Causes Mechanisms of Failure	Occurrence	Current Design Controls Prevention	Current Design Controls Detection (for DVP)	Detection	RPN
3	1.Spring wear	3	1.Maintain maintenance	1. Visual Inspection	1	9
3	1.Leave lever	3	1.Maintain maintenance	1. Visual Inspection	1	9
3	1.Method	3	1.Management of project	1. Visual Inspection	1	9
5	1. Wrong mounting	7	1.Management of project 2. Reassess assembly	1. Visual Inspection	1	35

Fig. 2: FMEA plotting

It was noted that some errors are motivated by common causes and should be monitored more actively. The effects, the causes and the actions proposed aiming at correcting the flaws.

As can be seen, figure 2 indicates the main fault profiles occurring in the period from the assembly of the p10 to its exit for packaging. In the mentioned table, we tried to describe only the causes of fault profiles that indicated greater risk within each one. Those functions whose risk was considered too small and of low interference in the problems that may have an impact on the GSIR were excluded.

The results obtained allow us to see that the errors with the highest risk index (NPR) were those associated to the spinning connection stage or electrical safety tests (HIPOT), which can generate problems with consumer safety. Because of the high severity of these errors, to solve this problem, it is recommended to use poka-yokes that guarantee the correct assembly of the electrical network. It should be remembered that a problem at this stage can lead to consumer discredit and even to consumer safety processes, generating irreversible costs for the company, as well as the negative impact on the field failure indicator.

V. FINAL CONSIDERATIONS

The current scenario, focused on the fierce competitiveness between companies to offer the best products and win the consumer preference, requires not only the practice of innovation, but the supply of high quality products and value added. Therefore, in order to avoid failures in the final product and consequently the generation of a negative image for the brand, it is necessary to apply methodologies for the improvement in the manufacturing processes of products.

Methodologies such as the FMEA, presented in this research, assure that failures during the manufacturing process are detected, preventing possible errors not previously foreseen in the process development phase. Used as a quality tool to detect potential failure modes in productive processes, FMEA will provide process reliability by preventing and eliminating errors, which is why its study and application in the white line industry should be increasingly emphasized.

The present case study allowed the practical visualization of the FMEA technique employed in the development of the production process of a mixed drinks machine in a white line industry. As discussed, the initial research problem consisted of the high and increasing index of field failures in the production process of the product in another manufacturing unit of the same group, generating impact on the quality indicators, besides costs and risks in the assembly, motivating the application this methodology.

In this way, first, the bibliographic research guided the use of this tool to ensure that the implementation of the project was robust and flawless, with analyzes put in place, measuring and stratifying all activities, so that no failure goes unnoticed. This type of study provided an environment with greater reliability, thus avoiding quality problems.

Then, with the analysis of the 10 assembly stations and their respective functions, it was possible to verify the mode of failure and effect that each causes in the process and in the final product, so as to prioritize the ones that have the greatest severity and to exclude those of low risk. With the application of the tool, it was observed that the highest severity index was in the stage of connection of wiring and electrical safety tests, which can be solved with the use of poka-yokes to ensure the correct assembly of the electrical network of the product, thus avoiding failures during the use by the final consumer.

Therefore, it is concluded that the FMEA is an efficient and low-cost tool, which makes it possible to verify the problems clearly, demonstrating the qualitative data in a quantitative way, pointing out those that should be prioritized. It is recommended to continue applying this method that contributes to the continuous improvement of the quality of the mixed beverage production process in this white line industry. It is also encouraged its use in other processes, since it promotes a macro view of each step, and can be applied in other types of products and industries.

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REFERENCES

- [1] SLACK, Nigel et al. Administração da produção. São Paulo: Atlas, 2015.
- [2] CARVALHO, Marly; PALADINI, Edson. Gestão da qualidade: teoria e casos. Elsevier Brasil, 2013.
- [3] FISCHER, Georg et al. Gestão da qualidade: segurança do trabalho e gestão ambiental. Tradução Ingeborg Sell, v. 2, 2009.
- [4] SELEME, Robson; STADLER, Humberto. Controle da qualidade: as ferramentas essenciais. Editora Ibepex, 2008.
- [5] PEINADO, Jurandir; GRAEML, Alexandre Reis. Administração da produção. Operações industriais e de serviços. Unicenp, 2007.
- [6] VIEIRA, Sonia. Estatística para a Qualidade. Elsevier Brasil, 2016.
- [7] CAMPOS, Vicente Falconi. TQC: Controle da Qualidade Total (no estilo japonês). Universidade Federal de Minas Gerais, Escola de Engenharia, 1992.
- [8] MCDERMOTT, Robin; MIKULAK, Raymond J.; BEAUREGARD, Michael. The basics of FMEA. SteinerBooks, 1996.
- [9] AMARAL, D.; TOLEDO, J. C. FMEA: Análise do tipo e efeito de falha. 2016.
- [10] PALADINI, Edson Pacheco. Gestão da qualidade: teoria e prática. In: Gestão da qualidade: teoria e prática. 2010.
- [11] BAER, Werner. A Industrialização e desenvolvimento econômico do Brasil. Fundação Getúlio Vargas, 1966.
- [12] MASCARENHAS, Henrique Ribeiro. O setor de eletrodomésticos de linha branca: um diagnóstico e a relação varejo-indústria. 2006. Tese de Doutorado.
- [13] GORENDER, Jacob. Globalização, tecnologia e relações de trabalho. Estudos avançados, v. 11, n. 29, p. 311-361, 1997.
- [14] CAMPOS, Henrique Moreira; OLIVEIRA, LH de. Estratégias da Indústria de Refrigerantes: um estudo sobre as "Tubainas". Encontro Científico da CNEC, v. 2, 2004.

Lean Manufacturing Application on Balancing of Mounting Line in a Company of the Two-Wheeled Pole of Manaus-Amazon Industrial Pole

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Abstract— In an assembly line system, raw material enters and progressively moves through a series of workstations while being transformed into the desired product. The production line balancing aims through effective activities and actions to ensure a continuous and level production, providing maximum productivity and efficiency while maintaining the proper work rhythm of the production process and avoiding wastage. Apply the balancing method in the processes that indicate difficulties to be accomplished, eliminate bottlenecks in the assembly line; increase the productivity indexes of the motorcycle production sector; measure the time of activities performed on the production line; analyze different methods, theoretical and practical balancing assembly production continuous model; improvements in Lean Manufacturing. The data collection was done through observation and documentation of the times of each job, in order to generate data to analyze productivity losses due to movements that do not add value or process poorly distributed. From these data, it was possible to observe that the poor distribution of the cycle times of some employees was outside the standard time of the assembly line, under such complexity, it was proposed to provide a new balance in the processes. In this way, it is possible to infer that the division of equal activities decreases the production cycle time in the stations and improves the productivity of the line.

Keywords— Process balancing, Lean Manufacturing, Takt time.

I. INTRODUCTION

The Industrial Hub of Manaus stimulated the formation of a productive chain with local, regional and national suppliers, with constant investments in innovative technologies, professional qualification and product development, being considered one of the most modern in Latin America, concentrating the largest Brazil, including Motorcycles [1], [2].

The MH company of Amazônia has 83% market share in the national two-wheeler market, is the largest motorcycle manufacturer in the country and the third largest manufacturer of motorcycles in the world, its activities establish links to the various regions of the country through subsidiary companies and suppliers that in a strategic and indispensable way promote the flow of goods, capital and information, consolidating an integrated space throughout the national and international territory [3].

The severe financial crisis requires companies to improve their performance, efficiency and productivity standards in order to make the best use of their resources and capabilities to survive in the market. From this perspective, the production line balancing (BLP) emerges as an important tool for obtaining improvements in this sector, such as: cycle time; productive capacity; resource utilization rate; degree of idleness of operators; among others [4], [5].

In the Assembly Line II sector of the MH Company of the Amazon, a series of problems that directly affected the production efficiency were evidenced. The failures caused by the poor distribution of processes generated significant disorders pointed out in the main key performance indicators of the sector.

The indicators of production, safety and quality (internal and external rejection) showed how the poor distribution of processes had a negative effect on results. Extremely high quality problems, poorly executed

production plan, fatigued and unmotivated collaborators, ever increasing field defect rate and some employees' cycle time out of standard assembly line time. In view of this, there was a need for a study with a new distribution of processes.

Considering the high productivity, cost reduction and quality maximization in the motorcycle production sector, the present study seeks to apply the balancing method following the Lean Manufacturing approach, as well as eliminate wastes, bottlenecks and stocks in processes that show failures in the motorcycle assembly sector.

II. THEORETICAL FOUNDATION

The theoretical bases are presented as references that served as a basis for the work developed, such as assembly lines, production line balancing and Toyota production system. Some important concepts were researched to develop an efficient implementation of process balancing in Assembly Line II of the company MH of the Amazon.

2.1 Assembly Lines

Assembly lines are production systems, defined as a finite set of manual or automated assembly workstations distributed throughout a drive system, developed for the industrial production of large quantities of products, such products are sequentially launched from station in season by a specific device such as treadmills, undergoing modifications until reaching the last assembly station [6].

The less time spent on tool stops, cleaning, maintenance and material handling, the better the productivity, other characteristics can be attributed to the lines [7], [8]:

According to many sources studied the main points to be raised in an assembly line are: set the cycle time; determine the number of workstations; balance LM and minimize lead time, among others.

In their work, [9] they mention that some terms used in the assembly line must be defined:

- Cycle Time: It is the time of each workstation of an assembly line to complete a set of specific tasks.
- Bottleneck: Machine or equipment that prevents constant performance in a process.
- Lead Time: Critical path of manufacture.
- Setup: elapsed time for an exchange of any running process until the initialization and adjustment of a next process.
- Takt Time: The production rhythm required to meet demand. Or it can be defined as, the maximum time that a unit of product must take to be produced [11].

2.2 Production Line Balancing

Production Line Balancing (BLP) is aimed at restoring continuous flow, eliminating bottlenecks that impede high productivity rates, is a waste reduction tool, especially by reducing operators' downtime [12]. It is the process in which the workload is divided between the operators in a production line so as to meet the time Takt time. A line is ideally balanced when each workstation produces synchronously and in the proper amount, generating a constant and uninterrupted flow in all stations of the line [13].

According to the authors [14], it shows that it is necessary for the production line balancing to analyze exactly or approximately the time of the activities of the collaborators, through this, it will be possible to verify the variation of the activities of the collaborators and to obtain the cycle time of each process within the assembly, the process with the longest cycle of the line directly affects the productivity, the association of the cycle time and the takt time is essential, because if the cycle time is smaller than the takt time the chances of occur excess production are greater, after the survey of the times, it is necessary to analyze the activities that interrupt the flow, which causes the waste.

2.3 Toyota Production System

Toyota found that the key to the operation was flexibility, that is, when you work with smaller lead-times and flexible production lines, you can achieve higher quality, greater customer response, higher productivity and better equipment utilization and space. The Toyota Production System (STP) prioritized the elimination of wasted time and material from each stage of the production process, broke paradigms in search of operational excellence. Before that, production systems were supported by the logic of mass production, following Fordist Production logic [15].

According to [16], "lean" production, or Lean Manufacturing, was the definition or term used to define this production system much more efficient, agile, flexible and innovative than mass production. For a factory to have a lean manufacturing system, it needs to transfer tasks and responsibilities to the workers that add value to the product and must have a system that identifies the defects as soon as they occur and discover the root cause of those defects. defects. It is to promote a harmonious flow of materials and information, between jobs and operators, so that it is produced in the right quantity and at the right time.

The "home" diagram, shown in Figure 1, shows that the basis of Lean Manufacturing is the total elimination of waste, as well as the main characteristics of the

methodology, as well as its two pillars, Just in Time and Jidoka - among other essential components of the system.



Fig. 1: Illustrative Representation of Lean Manufacturing

According to [18], the fundamental objectives of lean production are:

- Optimization and integration of the manufacturing system;
- Quality;
- Process flexibility;
- Production according to demand;
- Maintain commitment to customers and suppliers;
- Reduction of production cost;

2.3.1 The Seven Losses and Subsystems of the STP.

In his work, [19] presents the basic concepts of these losses.

- **Waiting:** Waiting time can be for employees waiting for the equipment, production lines waiting for parts, machines waiting for raw material exchange or waiting for repairs.

- **Defect:** Occurs due to failures in process, process operation and raw materials, ie if you have two options the part is discarded or it is reworked.

- **Transportation:** Moving materials more than necessary. Work teams and support teams should be nearby.

- **Movement:** Caused by poorly drawn layouts, obstacles in the way that cause the operator to divert to reach his destination.

- **Stock:** The excess of raw materials in the sheds, or areas intended.

- **Super Production:** It is the biggest waste of companies, also considered as the source of all other waste.

- **Super Processing:** These are the processes that occur inside the factory but are unnecessary for the good performance of the same.

III. TOOLS AND METHODS

The methodology adopted to carry out the course completion work consisted of a case study. The main focus of the case study is to demonstrate the multiple facts of variables that relate to the activities performed. The case study is a frequently used method for making decision-making or raising questions that aims to deepen knowledge in a particular area, in this way, this tool significantly helps the development of this project.

The case study does not follow a rigid script for its elaboration, but it is possible to establish four phases that show its delineation: a) Delimitation of the unit - case; b) Data collections; c) Selection, analysis and interpretation of data; d) Preparation of the report. [20].

3.1 Field Research Environment

The Assembly Line II sector has a productive capacity of 900 units in a shift, where its functionality establishes in only 1 Administrative shift, containing 79 employees in its production, divided into sub-tread with 40 employees and main treadmill with 39 employees. The main example is the model: K31 ABS.

The choice of this company to carry out this project is justified by the fact that the academic stage of the author of this work of conclusion of course occurred in this company. The research that covers this project was lifted and monitored from December 2018 until March 2019, aiming to collect data for the comparison of results already existing in company documents, giving veracity in the current data or helping in the continuous improvement of the company. The company works with a regular time of equal processes for all workstations, the production is elaborated according to the request of the authorized concessionaires where, through software, it performs an analysis respecting the productive capacity of the line, checking the possibility of generating a date and time for delivery of the product to the customer.

3.2 Tools Used for Time Study

The realization of the time studies had to use common tools in these methods of time collection, for the effectiveness and accuracy of the data found. The tools listed below are the main tools used for this type of research.

- Centesimal hour timer: check the cycle time of each workstation.

- Observation sheet: Carry out the annotation of the data found in the timing;

- Ballpoint pen: Record and record the data.

- Support clipboard: Support the observation sheet and stopwatch.

- Photographic Camera: Record process images in case of doubt.

3.3 Techniques Used for Collecting

The techniques used for data collection were divided in two, the first part in the Cronoanalysis of the data where the methods, tools, installations and materials used in the work were analyzed. This chronoanalysis assists in the execution of activities, through its measurements and evaluations it is possible to find a more reliable and accurate form of the time needed for an operator to perform certain work at a standard pace within a feasible time. In addition, the chronoanalysis evaluates layout, rationalization devices and also cares about ergonomics, providing contributions to the locomotion in the work space, as well as work position and posture suitability so that it does not cause damage to the whole operator's chrono-analysis was carried out through documents found in the company's database, where it detailed the details of the manufacturing process, such as standard time of each process, process cycle, models and several other data that directly contributed to the data collection.

The second technique was the observation and comparison of the data, where each employee's time of operation was rigorously recorded, a survey of each job, and interviews with employees to see their degree of empiricism and to verify where Lean Manufacturing helps with the use of Crono to find out where the process is wasting time or how to reduce process time.

3.4 Planning of the activities to be carried out (PDCA Cycle)

The planning of the case study, according to Figure 2, was organized with the PDCA tool, where the schedule of activities to be carried out was developed.

PDCA	FLOW	PHASE	GOAL	TOOLS
P	1	IDENTIFICATION OF THE PROBLEM	DISTRIBUTED PROCESSES	DATA AND HISTORICAL
	2	NOTE	CURRENT SITUATION	RESEARCH AND DATA COLLECTION
	3	ANALYZE	ANALYSIS OF SITUATION AND CAUSES	DIAGRAM OF CAUSES AND EFFECTS
	4	ACTION PLAN	STUDY OF THE CAUSES	BALANCE OF PROCESSES
D	5	EXECUTION	IMPLEMENTATION OF SOLUTIONS	ACTION
C	6	VERIFICATION	ANALYSIS OF RESULTS (BEFORE AND AFTER)	GRAPHIC COMPARISON
A	7	STANDARDIZATION	ACTION, BACKWARD BRAKE	-
	8	CONCLUSION	RESULTS AND BENEFITS	-

Fig. 2: Schedule of activities

The PDCA cycle is a managerial method that aims to guarantee the achievement of the goals necessary for the survival of an organization, taking the information as a factor for directing decisions. The steps that make up this cycle are: Plan (P - Plan), Execution (D - Do), Verification (C - Check) and Corrective Action (A - Action).

3.5 Main idea for conducting field research

The research began with the idea of raising the main negative determinants, which was directly interfering with the company's productive plan, where it was impossible to reach the goals of: quality, production, safety, absenteeism and operational satisfaction. At the outset there was the decision to work on each of these problems in isolation. However, the use of Ishikawa's tool or popularly known as fishbone, Figure 3, showed that it could not treat the conditioners as isolated cases, but rather as a single case that maintained correlation with others and directly influenced the productive goals. Cause and Effect Diagram (Ishikawa) is a technique used to explore and indicate the possible causes of a specific condition or problem.

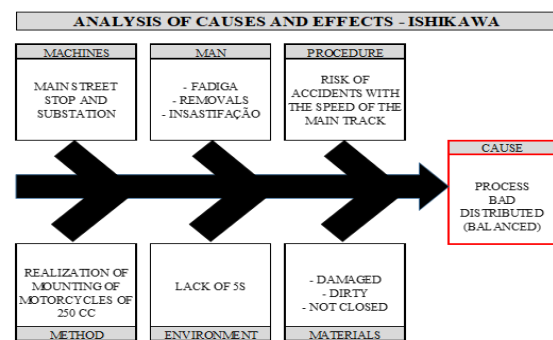


Fig. 3: Analysis of causes and effects (Ishikawa)

The result obtained with the use of the Ishikawa tool evidenced the root cause of the problem, indicating that the method of distribution of productive activities was wrong and needed a new process balancing. In this way, it was defined that the main idea was to balance the processes of Assembly Line II with the approach in Lean Manufacturing.

IV. BALANCING THE PRODUCTION LINE APPLYING LEAN MANUFACTURING

Field research was carried out with the objective of elaborating the balancing of Assembly Line II and defining the action plan to achieve the objectives of this course completion work. Figure 4 shows the steps taken to prepare this research.

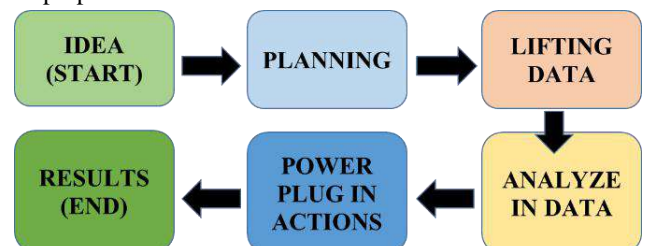


Fig. 4: Flowchart of the steps taken to prepare the field research

Each stage of the process was carried out with the aim of standardizing the research process.

4.1 Data collection.

Initially, the detailed timing of each workstation was generated generating the time and process table and, consequently, the main data, which determine the time and task that each operator was performing at the assembly station.

Subsequently, internal documents provided by the production control sector were verified, to ascertain the status of the indicators, such as: quality indicators; absenteeism; training and satisfaction. Aiming to study their relationships with the current problem of balancing process.

4.2 Analysis of the data.

The analysis of the collected data is the main part of the research, because through a good analysis it achieves great results. The first data collected were collecting and timing to obtain the time each operator performs a certain operation. The workstations, operators and times of each Workstation follow in Tables 1 and 2. Colab. for Collaborator, Lower Limit (L.I), considers (88% of Takt), Meta represents (94% of Takt) and Upper Limit (L.S) (Over 94% of Takt).

Tab. 1: Time per process of each employee (1 to 39 Sub Track / 40 to 79 - Main Track)

TIME TABLE OF PROCESSES							
COL.	POST	TIME	L.I	GOAL	L.S	TAKT	%
1	OPER 1	37,47	35,20	37,60	37,61	40	94%
2	OPER 2	36,97	35,20	37,60	37,61	40	92%
3	OPER 3	37,45	35,20	37,60	37,61	40	94%
4	OPER 5	36,80	35,20	37,60	37,61	40	92%
5	OPER 6	37,35	35,20	37,60	37,61	40	93%
6	OPER 8	35,00	35,20	37,60	37,61	40	88%
7	OPER 9	37,42	35,20	37,60	37,61	40	94%
8	OPER 18	37,22	35,20	37,60	37,61	40	93%
.
79	OPER 113	30,88	35,20	37,60	37,61	40	77%

Each job was timed in detail to its execution, followed by the annotation of each action performed by the employee, after obtaining the detailed time, the samples were added generating a final result of each job. After the collections were carried out on the assembly conveyors, the process balancing chart was elaborated, Figure 5, a graph that clearly showed the time of each workstation.

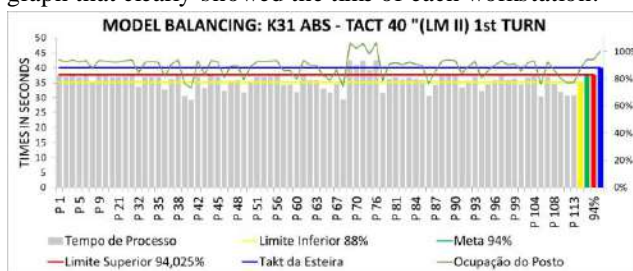


Fig. 5: Process Balancing Chart

With the process balancing chart, it is clear that some processes were experiencing difficulties. Posts 70 and 74 were at or above the takt of 40 seconds, this limit was a risk that should be studied in more detail, because there was a great hypothesis that the employee had signs of overload. At the 69th, 72nd and 76th positions, it was above takt, becoming the production bottleneck, thus, the number of line stops caused by bottleneck was great. In addition, not only did it contribute to the line stops, but also to the employee's ergonomics.

There were 27 jobs in idleness problems (below the lower limit), employees were idle, their cycle time was well below the scheduled takt, this idleness could lead to distractions and forgetfulness in the operational achievements, generating defects that reflected directly in the sectoral quality index. Some employees complained that their posts were causing discomfort and great pain, due to poor distribution of the processes. Finally, the other processes were feasible, but their efficiencies are lower than expected.

4.3 Analysis of the graphs.

In order to understand and understand the problems that occur within the sector of Assembly Line II, the production indicators were studied to identify the contribution that each indicator showed in relation to the non-length of the targets.

Observing the difficulties encountered in the balancing process, it was decided to analyze indicators that maintained a correlation with the production. Among them: general quality chart, sector quality chart; graph of absenteeism and finally a graph of sectorial satisfaction.

4.3.1 General Quality Chart

The first graph analyzed was the general quality chart, this graph is responsible for demonstrating all the quality problems of Assembly Line II. The graph presented in Figure 8 was analyzed in the period from September to November 2018. It was observed that in September there were 61 quality problems, in October 45 problems and finally in November 65.



Fig. 6: General Quality Chart

4.3.2 Sector Rejection Chart

The overall quality chart, Figure 7, shows that in September, October and November, there were 171 problems with quality. This amount caught the attention because it contained a very high sectoral rejection rate in its participation. Of these 171 problems it was found that 111 problems were directly directed to Assembly Line II.

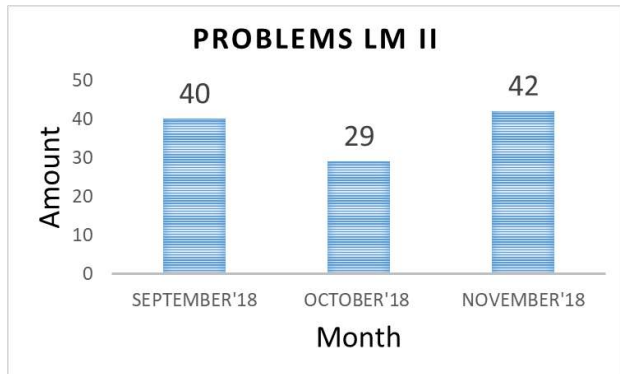


Fig. 7: Sector Rejection Chart

4.3.3 Chart of sector absenteeism

Graph of absenteeism shows the number of employees who were absent from the sector in the period of September, October and November. It is divided into two parts: employees who moved away in relation to the process, examples: right and left shoulder injury, accidents for not performing process correctly, back pain and only by ergonomic conditions and those that have no relation with the process, for example: intestinal pain, headache, parental leave, dentist, and outings for particular subjects.

Because it is related to production, the graph, Figure 8, was analyzed and gained attention to help in understanding the situations that occurred in the Line II sector.

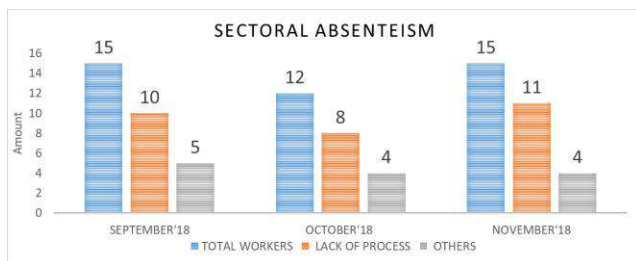


Fig. 8: Sector Absenteeism Chart

4.3.4 Sector Satisfaction Graph

Graph of sector satisfaction, Figure 9, one of the most important graphs of the company, since its function is to demonstrate the employees' satisfaction with the company. There are 3 criteria used for evaluation, the developer chooses which of the options he is most dissatisfied. The reference of the greater, the better (1 to 10) is used.

1st MANAGEMENT: the employee analyzes how the sector's management is being carried out, whether its leaders are listening to employees or whether they are attending in an equal way to all;

2 ° PROCESS: dissatisfaction with the process, being: too fast, in the bottleneck, long time in the same process or fatigued;

3 ° SECTOR: Analysis of the sectoral organization is taking care of and respecting the space of the employee, if the necessary tools for the operations are being offered.

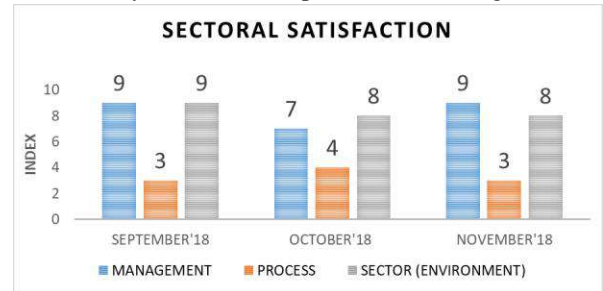


Fig. 9: Sector Satisfaction Graph

4.4 Action Taken

After defining that the most conceptual solution should be the realization of process balancing with approach in the philosophy Lean Manufacturing, took the action of creating a new vision of work in the sector of Assembly Line II. The implementation was carried out in December 2018 and based on the data, the best strategy was set up to obtain a good result in the indicators to be reflected mainly in the first few months of 2019.

V. RESULTS

With the applied balancing, the results obtained were excellent, in the production indicators showed that the process balance that was based on lean philosophy, transformed the work environment, giving a new form of execution of the sectoral activities. The results were acquired through much analysis of studies carried out. Colab. for Collaborator, Lower Limit (L.I), considers (88% of Takt), Meta represents (94% of Takt) and Upper Limit (L.S) (Over 94% of Takt). After balancing table 2, it shows the results achieved.

Tab. 2: Time per process of each employee (1 to 39 Sub Track / 40 to 79 - Main Track)

TIME TABLE OF PROCESSES							
COL.	POST	TIME	L.I	GOAL	L.S	TAKT	%
1	OPER 1	37,47	35,20	37,60	37,61	40	94%
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5	OPER 6	37,00	35,20	37,60	37,61	40	92%
6	OPER 8	35,25	35,20	37,60	37,61	40	88%
7	OPER 9	36,72	35,20	37,60	37,61	40	92%
8	OPER 18	36,22	35,20	37,60	37,61	40	91%
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79	OPER 113	36,72	35,20	37,60	37,61	40	92%

With the process balancing chart, Figure 10, it is evident that the most critical processes have been adjusted as Lean improvements. Posts 70 and 74 were at or above the takt of 40 seconds because the employee really had signs of overload. At stations 69, 72 and 76, it was above the takt, in which the necessary balancing of the process distribution was performed, removing the production bottleneck at these stations, in this way, the number of line stops caused by the bottleneck decreased significantly. In addition, line stops were no longer occurring in relation to these overloaded stations. Consequently, the ergonomics of employees in these core processes.

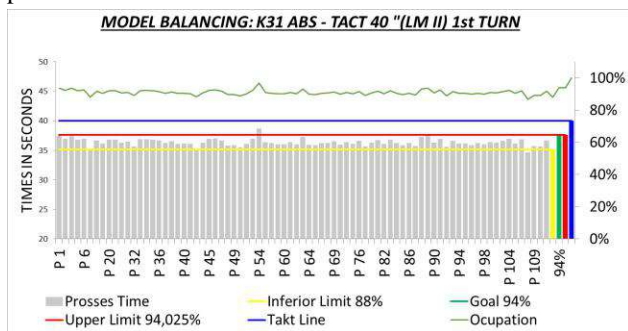


Fig. 10: Process Balancing Chart

5.1 General quality chart

The general quality chart, responsible for being a main indicator in the monitoring of defects occurred inside the factory.

After balancing, we obtained satisfactory results. Where in the month of January the index fell to 10 defects month, in February 12 defects month, and in March were only 9 defects, with this we can see in Figure 11 that there is a relationship of monthly defects with the new process balancing.



Fig. 11: General Quality Chart

5.2 Sector Rejection Chart.

The sector rejection graph is responsible for indicating the quality problems that occur within the sector of Line II, is extracted from the general quality chart, where its

modality is to analyze in a coherent way how is the sector performance, in the chart below, we can to observe how the application of the balance had a direct effect on the sector, giving a 89% efficiency in the sectorial quality, in relation to the previous one. The results obtained after the balancing were that in January we obtained only 6 defects, in the month of February only 5 defects and in the month of March 6 defects, as shown in Figure 12.



Fig. 12: Sector Rejection Chart

5.3 Chart of absenteeism

Responsible for indicating the employee absence index. With the new process balancing in figure 13, the absences from the process decreased by 89.65% in relation to the previous balance.

The good result is due to the new way of performing the sectorial activities, because the temple cycle employees are in accordance with Takt.

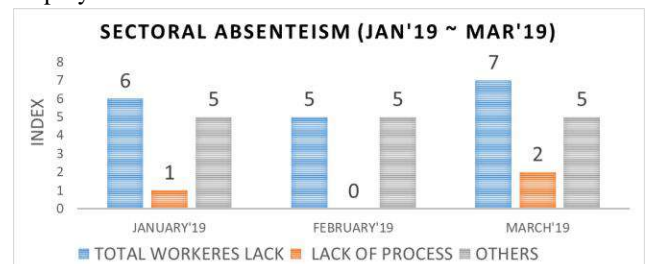


Fig. 13: Absenteeism Chart

5.4 Sector Satisfaction Graph

The sector satisfaction chart in figure 14 is extremely important, since its indicators are aimed at reporting and analyzing the situation of employee satisfaction through management, process and sector management. With application of process balancing based on the lean manufacturing philosophy, the process dissatisfaction index reduced by 89.3%, making it very acceptable for our research, according to Figure 14.



Fig. 14: Sector Satisfaction Graph

The research as an important and delicate subject obtained an expected and acceptable result, the application of the process balance based on the lean manufacturing philosophy showed us how the balance can be adopted as a tool of sectoral leverage. It is evident that the sector achieved good results and great performance after the application of this tool, today it is possible to observe collaborators more satisfied with their processes, where the best result in all the research is to guarantee the productivity of the company and the satisfaction of our employees and customers.

VI. FINAL CONSIDERATIONS

The study developed in this work aimed at the application of the balancing, based on lean manufacturing, in a assembly line of the two wheel segment.

The importance of planning for the implementation of the balancing was presented, analyzing the time of transformation of the product and demonstrating the practices adopted to make improvements within the sector of Assembly Line II. The proposal to achieve higher productivity of the assembly line was to map the processes and collect the cycle times of each employee.

The application of the lean manufacturing approach allowed the transformation of the productive environment, reducing the process cycle, eliminating bottlenecks, waste, separation from injuries, and allowed productivity gains and efficiency, generating a high social prestige for employees.

Lean's approach enabled the company to prevent wasted materials in process and eliminate products that did not add value to the industry. The reduction of waste does not make the end of this tool, a work environment must be in continuous improvements always aiming the well being of its employees and customers.

Main contribution of this course completion work is to demonstrate the path of production balancing by adopting a lean manufacturing philosophy.

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REFERENCES

- [1] DA SILVA, Denilson Costa; DE ARAÚJO ICHIHARA, Jorge. BALANCEAMENTO DE LINHAS DE PRODUÇÃO DE UMA EMPRESA DE CERÂMICA VERMELHA DE SÃO MIGUEL DO GUAMÁ ATRAVÉS DE SIMULAÇÃO DE EVENTOS DISCRETOS. REVISTA PRODUÇÃO E ENGENHARIA, v. 8, n. 1, p. 679-695, 2017.
- [2] FERREIRA, Sylvio Mário Puga; BOTELHO, Lissandro. O emprego industrial na Região Norte: o caso do Polo Industrial de Manaus. estudos avançados, v. 28, n. 81, p. 141-154, 2014.
- [3] MORAES, Elias Oliveira; NOGUEIRA, Ricardo José Batista. Corporação em rede: Um estudo sobre a empresa MH da Amazônia. Rev. Cadernos do Núcleo de Análises Urbanas, Manaus, v.7, n. 1, p. 112-129, 2014
- [4] FAVONI, Célio; GAMBI, Lillian Nascimento; CARETA, Catarina Barbosa. Oportunidades de implementação de conceitos e ferramentas de Produção enxuta visando melhoria da competitividade de empresas do Apl calçadista de jaú/sp. Revista Produção Online, Florianópolis, SC, v.13, n. 3, p. 1118-1142, jul./set. 2013.
- [5] ALMEIDA, Rodrigo Pessotto; WERNER, Liane. Uma revisão sobre abordagens que relacionam os custos de Produção e o processo de previsão de demanda. Revista Produção Online, Florianópolis, SC, v.15, n. 2, p.504-526, abr./jun. 2015.
- [6] SOBREIRO, Vinicius Amorim; NAGANO, Marcelo Seido. Produção baseado na teoria das restrições e no problema da Mochila. Revista Produção Online, Florianópolis, SC, v.13, n. 2, p. 520-543, abr./jun. 2013.
- [7] BOCK, S. Using distributed search methods for balancing mixed-model assembly lines in the automotive industry. OR Spectrum, v. 30, n. 3, p. 551-578, 2008.
- [8] BECKER, C.; SCHOLL, A. A survey on problems and methods in generalized assembly line balancing. European Journal of Operational Research, v. 168, n. 3, p. 694-715, 2006.
- [9] BOYSEN, N.; FLIEDNER, M.; SCHOLL, A. Sequencing mixed-model assembly lines: 12 p. Survey, classification and model critique. European Journal of Operational Research, v. 192, n. 2, p. 349-373, 2009.
- [10] PAWLAK, Jeferson Silveira; MACEDO, Marcelo. Princípios do Lean Manufacturing aplicados em uma fábrica de injeção de peças plásticas: análise do resultado operacional. Rev. Produto & Produção, vol. 15 n.4 p. 55-67, 2014.

- [11] OLIVEIRA, Ricardo Becker Mendes; CORRÊA, Valesca Alves; NUNES, Luiz Eduardo Nicolini Patrocínio. Mapeamento do fluxo de valor em um modelo de simulação Computacional. Revista Produção Online, Florianópolis, SC, v.14, n. 3, p. 837-861, jul./set. 2014.
- [12] PEREIRA, Carla Roberta; COSTA, Miguel Antonio Bueno. Um modelo de simulação de sistemas aplicado à programação da Produção de um frigorífico de peixe. Revista Produção Online, Florianópolis, SC, v.12, n. 4, p. 972-1001, out./dez. 2012.
- [13] SANCHES, Alexandre Leme. Sequenciamento de linhas de montagem múltiplas no ambiente de produção enxuta – um estudo simulado para minimizar o risco de paradas. Rev. P&D em Engenharia de Produção v. 08 n. 01 p. 06-10, 2010.
- [14] PACHECO, Diego Augusto Jesus; LACERDA, Daniel Pacheco; CORCINI NETO, Secundino Luis Henrique; JUNG, Carlos Fernando; ANTUNES JÚNIOR, José Antônio Valle. Balanceamento de fluxo ou balanceamento de capacidade? Análises e proposições sistêmicas. Rev. Gest. Prod. v. 31, n. 5, p. 1097-1115, 2013.
- [15] JUSTA, Marcelo Augusto Oliveira; BARREIROS, Nilson Rodrigues. Técnicas de gestão do sistema toyota de produção. Revista Gestão Industrial, v. 05, n. 01: p. 01-17, 2009.
- [16] PACHECO, Alan Pereira Amorim. O viés da industrialização sob a ótica da produtividade. [Trabalho de Conclusão de Curso], Universidade Federal do Rio de Janeiro, Rio de Janeiro, 2016.
- [17] BEZERRA, Marlene Jesus Soares; ALBUQUERQUE, Iram Vitoriano. Aplicação do ciclo PDCA no grupo cultural Reconca Rio. Revista Tecnologia & Cultura. n. 25, p. 78-84, Rio de Janeiro, 2015.
- [18] PERGHER, Isaac; RODRIGUES, Luis Henrique; LACERDA, Daniel Pacheco. Discussão teórica sobre o conceito de perdas do Sistema Toyota de Produção: inserindo a lógica do ganho da Teoria das Restrições. Rev. Gest. Prod., São Carlos, v. 18, n. 4, p. 673-686, 2011.
- [19] ANTUNES, Junico. Sistemas de Produção: Conceitos e práticas para o projeto e gestão da produção enxuta. Porto Alegre: Editora Bookman, 2008.
- [20] Gil AC. Como elaborar projetos e pesquisa. 3a ed. São Paulo: Atlas; 1995:58.

Calculation of the Yield of an Alcoholic Fermentation

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Abstract— This study is associated with a result of an industrial process in the measurement of fermentative efficiency using physico-chemical data obtained routinely in the laboratory. In Brazil, besides sugar, final molasses, which is a by-product of sugar production, is also used in the production of ethanol. The alcohol is obtained after the fermentation of the broth or a mixture of molasses and broth, which consists of a biochemical process. Before being sent to fermentation the broth should be purified. The results obtained in the laboratory showed that the fermentation presented a yield of 91.55% (CTC Method) and 91.39% (Fermentec Method), close yields from 86.3 to 93.4% quantified in two harvests (2010 and 2011) operating in batch fed as in the current work.

Keywords— alcohol, fermentation, sugar and ethanol industry, ethanol methodology, fermentative yield.

I. INTRODUCTION

According to Lima et al., (2001), alcoholic fermentation has three main phases: preliminary phase, tumultuous and final or complementary phase. In the industrial operation, in the fermentation, yields from 86.3 to 93.4 were quantified in two harvests “2010 and 2011” Andrietta et al., (2012) operating in batch fed as in the current work. Silva et al., (2017) report that in the 2014/2015 harvest in industrial processing, fermentation efficiency of 89.99% was obtained; in the 2015/2016 crop, 92.04% were obtained. This shows that the fermentative efficiency varies between different harvests. The importance of this study is the use of experimental industrial results obtained in the sugarcane harvest of 2017, and uses them in the quantification of the fermentative yield, as carried out in the industry. The objective of this work is to show the results of the experiment performed in the laboratory of sugar and ethanol plant, in 24 hours of operation, comparing the methods of CTC (2005) and Fermentec, Silva et al., (2003) in the evaluation of the yield of alcoholic fermentation.

II. METHODOLOGY

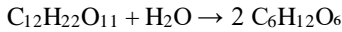
The methodology used in this study consists of the use of experimental data of an industrial process in operation, using them to obtain the fermentative yield of the process described below. The must to ferment must have the concentration between 19 and 23° Brix; thus, the mixed broth is standardized with the addition of residual molasses from the manufacture of sugar or syrup from the evaporators. Yeasts produce a set of enzymes that

catalyze the fermentation reaction with conversion of the sugars into ethanol. The formation of other compounds occurs during fermentation, such as glycerin, succinic acid, amyl, isoamyl, butyl and other alcohols. In the alcoholic fermentation in Brazil, the use of the discontinuous Melle-Boinot system is common. The yeasts are reused after separation by centrifugation of the fermented must in two fractions. Yeasts are sent to an acid treatment tank for reuse. The reuse of yeasts in subsequent fermentations minimizes cell multiplication. Thus, the sugar consumed converts to ethanol. The centrifuged wine is stored in a flywheel and is then distilled. The physico-chemical methods used in the industry where the present study were carried out was described in (Silva et al., 2003). Industry software uses the equations described in the document. The efficiency of the alcoholic fermentation were obtained under the determination of the ethanol produced as a function of the Mass of Total Reducer Sugar, fed daily in the fermentation process or Residual Reducing Sugar of the dorna, with the practical equations used in the industry: "CTC" and "Fermentec".

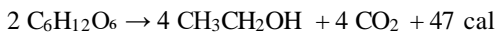
After carrying out the primary sieving treatment, calcium hydroxide is added to the broth, following heating and subsequent decantation, treatment similar to that used in the manufacture of sugar. The cooling of the broth is carried out in two stages: in a heat exchanger (regenerative) operating countercurrent with the cold mixed broth, the broth being cooled to about 60°C; final cooling to approximately 30°C, in plate changer with water flowing in countercurrent (COPERSUCAR, 2010). The fermentation, where the conversion of the sugars into

ethanol takes place, was carried out, in most cases, in a discontinuous way in dornas. Yeasts produce a set of enzymes that catalyze the fermentation reaction. In spite of the complexity, for practical purposes one can represent the conversion according to the following steps:

- Saccharification: Consists of the hydrolysis of sucrose by the action of invertase.



- Alcoholic fermentation: Consists of the conversion of glucose and fructose into ethanol by the action of zymase.



Invertase and zymase are the enzymes produced by yeast. Formation of other compounds occurs during fermentation, such as glycerin, succinic acid, amyl, isoamyl, butyl, and other alcohols. In the alcoholic fermentation in Brazil, it is common to use the Melle-Boinot discontinuous system. Yeasts are reused after separation by centrifugation of the fermented must in two fractions: yeast milk and wine as shown in Figure 1.

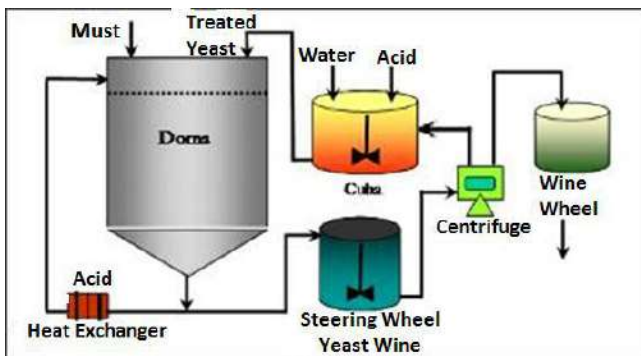


Fig. 1: Fluxograma da Fermentação Melle-Boinot (TANCREDO, 2010).

Using practical equations of CTC (2005), the experimental results allow to quantify fermentation yield and other parameters, such as yeast loss (kf); produced glycerol (kg); losses of total sugars (kart); acidity (kac), fermentative yield (RF).

Table 1. Results of analyzes

DESCRIPTION	UNIT	RESULT
Acidity in must (AM)	g/l	0.96
Yeast in the cuba (YC) (m/m)	%	40.15
Alcohol content in the cuba (ACC)	°GL	5.81
Acidity in the cuba (AC)	g/l	2.22
Yeast in the dorna (YD) (m/m)	%	11.99
Alcohol content in dorna (ACD)	°GL	9.85

Acidity in dorna (AD)	g/l	1.22
Glycerol in dorna (m/m)	%	0.37
Total Residual Reducing Sugar in Dorna (m/m)	%	0.21
Alcohol content in the steering wheel	°GL	9.74
Yeast content in the flywheel (m/m)	%	1.10
Conversion factor of yeast content in dry mass	-	0.33
Specific mass of alcohol at 100%	-	0.7893
Must volume	m ³	7,749
Total Reducing Sugar in Must (TRSM) (m/m)	%	19.28
Volume of wine in the dorna	m ³	10,808
Volume of yeast treated in the tank	m ³	3,120
Volume of water in CO ₂ washing (VW)	m ³	432
Alcohol content in CO ₂ washing water (ALC)	°GL	1.38
Volume produced of absolute alcohol (VPA)	m ³	923

$$k_f = \frac{\text{Yeast content in the flywheel} \cdot 0.33}{\text{Alcohol content in the steering wheel} \cdot 0.7893} \quad (1)$$

$$k_f = \frac{1.10 \cdot 0.33}{9.74 \cdot 0.7893} = 0.0472 \text{ kg/kg}$$

$$k_g = \frac{\text{Glycerol in dorna}}{\text{Alcohol content in the steering wheel} \cdot 0.7893} \quad (2)$$

$$k_g = \frac{0.37}{9.74 \cdot 0.7893} = 0.0481 \text{ kg/kg}$$

$$k_{art} = \frac{\text{Total Residual Reducing Sugar in Dorna}}{\text{Alcohol content in the steering wheel} \cdot 0.7893} \quad (3)$$

$$k_{art} = \frac{0.21}{9.74 \cdot 0.7893} = 0.0273 \text{ kg/kg}$$

$$k_{ac} = \frac{[AD - ((\frac{\%YD}{\%YC}) \cdot AC) - ((1 - \frac{\%YD}{\%YC}) \cdot AM)]}{[\frac{ACD}{100} - ((\frac{\%YD}{\%YC}) \cdot \frac{ACC}{100})]} \cdot 1.837 \quad (4)$$

being: YD = yeast in the dorna; YC = yeast in the cuba; AD = Acidity in Dorna; AC = Acidity in the Cuba; ACD = Alcohol Content in Dorna; ACC = Alcohol Content in the Cuba; AM = Acidity in Must.

$$k_{ac} = \frac{[1.22 - ((\frac{11.99}{40.15}) \cdot 2.22) - ((1 - \frac{11.99}{40.15}) \cdot 0.96)]}{[\frac{9.85}{100} - ((\frac{11.99}{40.15}) \cdot \frac{5.81}{100})] \cdot 789.3} \cdot 1.837 = -0.0033 \text{ Kg/Kg}$$

$$RF = \frac{100}{(1 + 1.19 \cdot K_f + 0.50 \cdot K_g + 0.51 \cdot K_{ac} + 0.51 \cdot K_{art})} \quad (5)$$

$$RF = \frac{100}{1 + 1.19 \cdot 0.0472 + 0.50 \cdot 0.0481 + 0.51 \cdot (-0.0033) + 0.51 \cdot 0.0273} = 91.55\%$$

The system of calculation of yield using the Fermentec method, Silva et al., (2003) uses the equations:

$$\text{Liters of recovered alcohol CO}_2 = \frac{VW \cdot ALC \cdot 100}{VPA} \quad (6)$$

being: VW = volume of water in CO₂ washing; ALC = alcohol content in CO₂ washing water; VPA = Volume produced of absolute alcohol.

$$\text{Liters of recovered alcohol CO}_2 = \frac{(432 \cdot 1.38) \cdot 100}{923} = 74.42 \text{ m}^3$$

$$APF = ([1] \cdot [2]) - ([3] \cdot [4]) + [5] \quad (7)$$

being: APF = Alcohol Produced in Fermentation; [1] Volume of wine in the dorna; [2] Alcohol content in dorna; [3] Volume of yeast treated in the tank; [4] Alcohol content in the cuba; [5] Liters of recovered alcohol CO₂.

$$APF = (10,808 \cdot 9.85) - (3,120 \cdot 5.81) + 74.42 = 88,406.02 \text{ m}^3$$

$$RF = \frac{APF}{(\text{Must volume} \cdot TRSM \cdot 0.006475)} \quad (8)$$

being: TRSM = Total Reducing Sugar in Must.

$$RF = \frac{88,406.02}{(7,749 \cdot 19.28 \cdot 0.006475)} = 91.39\%$$

III. RESULTS AND DISCUSSIONS

With the physicochemical analyzes performed in the laboratory to monitor the entire industrial process, the industrial results shown in Table 1 are reached.

The two calculation methods "CTC and FERMENTEC" presented similar results. Therefore, both methods are suitable for quantifying the fermentative yield. In addition, the results were close to the upper limit of the range reported in the literature: 86.3 to 93.4% (Andrietta et al., 2012).

The final fermentative yield of the CTC and Fermentec Methods were 91.55% and 91.39%, respectively. These results are used in the manufacture of ethanol, in process control, when fermentative efficiency is reduced.

IV. CONCLUSION

With the results of the analyzes presented in Table 1, used in the previous equations, the fermentation presented a yield of 91.55% (CTC Method) and 91.39% (Fermentec Method), close to the higher values obtained in ethanol plant in Brazil, which is 86,3 to 93,4%. The result shows the importance of obtaining data from the units with the physicochemical analyzes to obtain the efficiency of the process.

REFERENCES

- [1] CTC, Canavieira Technology Center (2005). Manual of analytical methods chemical control of fermentation Laboratory analysis.
- [2] D. C. M. N. Silva, F. F. Barbon, R. B. Branzato, (2017). Comparison of fermentative efficiency in ethanol production by native and commercial strain of *saccharomyces cerevisiae* Revista Científica de Ciências Aplicadas – FAIP. 7, pp. 12-30.
- [3] L. F. L. F. Silva, C. D. Bernardino, F. E. Ré, C. H. F. Furtado, H. V. Amorim (2003). Analytical methods for the control of sugar and alcohol production Fermentec. p. 458.
- [4] M. O. C. Tancredo (2010). Comparison between mill and diffuser. University of Franca. Graduation work (TCC). p. 63.
- [5] S. R. Andrietta, M. G. S. Andrietta, M. H. P. Bicudo (2012). Comparison of fermentation yield using different calculation: methodologies for the evaluation of the performance of an industrial process. Stab. 4, pp. 41-49.
- [6] U.A. Lima, E. Aquarone, W. Borzani, W. Schimidell (2001). Industrial Biotechnology: Fermentation and: Enzymatic Processes São Paulo: Edgard Blücher. p. 593.

Factors that Influence Organizational Climate in an Institution of Higher Education in the State of Tocantins

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Abstract—Organizational climate (CO) is commonly defined as an arrangement of estimable properties of the work environment, being these properties noticed directly or indirectly by the individuals that attend and work in this environment and that interferes in the motivation and the behavior of these people. The present work brings the organizational climate as an indicator of satisfaction of the members of a certain company located in the state of Tocantins, taking into account different aspects of the culture and the current reality of the institution in question. So, the results of the applied research in this institution will reveal the reality observed by the collaborators and not only what happens legitimately.

Keywords—Evaluation, management, development, achievement.

I. INTRODUCTION

Currently, we live in a dynamic world, where organizations have experienced profound and complex changes, going on so the need for new forms of more agile, flexible and that values human relationships. Thus, required a change in the organizational environment of the company concerned. There's no way to talk about organizational climate (CO) without first defining what is organizational culture, because the culture is the cause, and the climate is a result of it.

Every organization has your culture, regardless of your size, being formed by the values, beliefs, customs, traditions, i.e. the culture shapes the identity of an organization [1]. Thus, the climate is a result of perceptions that employees have of the different aspects that influence your well-being and your satisfaction in day to day work. Thereby the climate of a company relates basically to the perception of the quality of life at work. Having the CO a situation where the developer is within the work environment, that influence on your behavior so positively as negatively. Currently, organizations undergo constant changes going on so the need to search for innovation, productivity and profitability [2, 3].

Stress, motivation, leadership are some of the factors that are associated with the CO, its factors must be taken into consideration for a good performance and a healthy environment within the organizations, people need to feel

motivated to which have involvement and commitment.

When the personal needs of participants are matched, the CO is favorable, raising morale. And frustration, when these same needs are not met. The CO is to analyze the internal environment, the company must raise the level of motivation of its employees, while the same attempt to achieve their personal goals, thus consequently reach company objectives [4] [5]. This way up which factors influence the organizational climate of the institution, as well as analyze the salaries and the length of service. The General conditions in the workplace as hygiene, temperature, plant and equipment and assess the degree of cooperation and motivation among the employees of the company to obtain a degree of employee satisfaction analysis in relation to the institution.

II. MATERIALS AND METHODS

The survey was conducted in the UFT, located on the street Badejós, 69/72 Farms, s/n-Rural area, no. 7, 77402-970, Gurupi-TO.

The present work had focused on analyzing the factors that influence the CO at the institution where the research, based on the classification of [6] which features two ways to search: about the purposes and as to the means. As the purposes may be considered exploratory and descriptive. Exploratory, because the search does a bibliographic survey about the CO and better understand it. Already, attempts to

identify the factors that influence the CO through questionnaires to ascertain the facts to applicants in order to resolve the problems encountered [7].

The research in question is how population all administrative employees of the Federal University of Tocantins, where will be held the search properly active in the company. The application of questionnaires will be held in the period between September and October 2017. The study tends 100% sampling of employees.

In order to assess the factors that influence the CO, the researcher prepared as a tool for research, questionnaires containing questions multiple choice closed, clearly and objectively for data collection, being applied in the University Federal do Tocantins, with date and times marked by the direction of the company, in a manner not detrimental to the services of the employees.

Through the questionnaire with the 15 questions will be collected the data for this research, the information given by way of manual tabulation, where, all the questions are closed, treated and represented by percentages expressing consistency, where the treatment of the same will be done through the Microsoft Excel 2016, for the quantitative research through tables.

III. RESULTS AND DISCUSSION

The presentation and analysis of data intended to show the profile of the employees of the research and the results of their perceptions about the following variables: infrastructure, social environment, in terms of staff, leadership and hierarchy, assessing this way to satisfaction of these in relation to these variables in order to examine how the organizational climate portrays the company in question. The research was done in order to highlight the opinions and criticism on a daily basis by the employees and managers of the company. Excellent results were obtained during the research, with information sought

appropriate solutions to possible changes and progress of the organization.

It is worth saying that the lifting of the level of satisfaction of employees is essential to designate and support the decisions of managers, as well as determine the situation of the quality of life of employees, because if this quality of work is disadvantaged, will impel the disinterest of the employee and dissatisfaction, as well as decreased productivity and harmful behaviors as an example of excessive absence, turnover, sabotage, trade union militancy and in the worst cases even stealing. Employee satisfaction also becomes essential to provide reliable references about a specific environment for performing actions that are able to magnify the motivation, thus creating a kind of participatory and effective in spirit employees, guiding the company through paths that lead to excellent levels of productivity and personal and social commitment.

The research instrument was divided into two parts, first collected personal data (age, sex, educational level and your position in the company). With that, finding 9 employees male and 7 female, all between the ages of 30 to 50 years, with complete higher education and length of service are between 3 and 6 years, with two of these with a time over 10 years.

Later, the issues related to the working environment of employees where they were selected for the exhibition of the results only most relevant issues among the 20 that was on the questionnaire. These results will be presented in graphic format, followed by a brief commentary on the results obtained.

Chart 1: how you qualify the work environment, taking into account aspects such as ergonomics, noise, light, temperature, and hygiene?

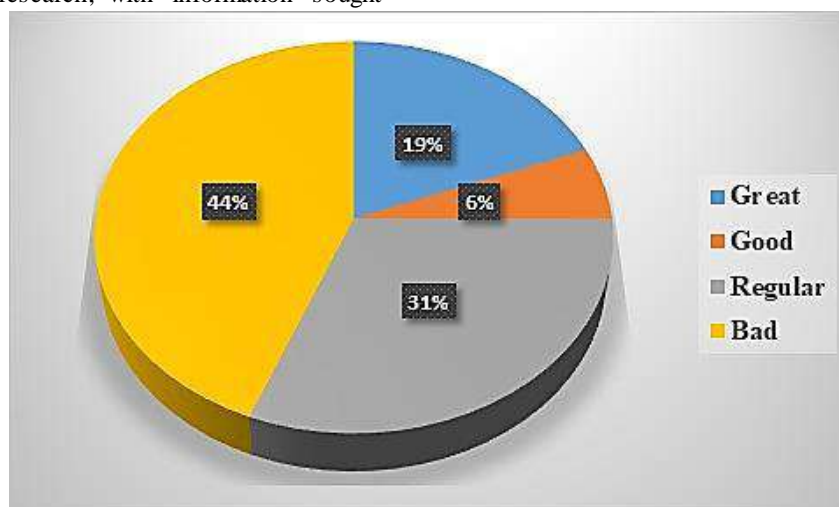


Fig. 1: Source: Own elaboration

The first question refers to the quality of your workplace with regard to aspects such as ergonomics, noise, light, temperature, and hygiene. On the basis of the answers presented in chart 1, one can realize that the quality of the workplace does not have very pleasant conditions, whereas the highest percentage (44%) declared the situation as bad,

followed by (31%) opening as regular, while (19%) excellent and only declared (6%) stated as well.

Chart 2: the attributes of the task that you're playing, as the level of responsibility, for example, contribute to your motivation?

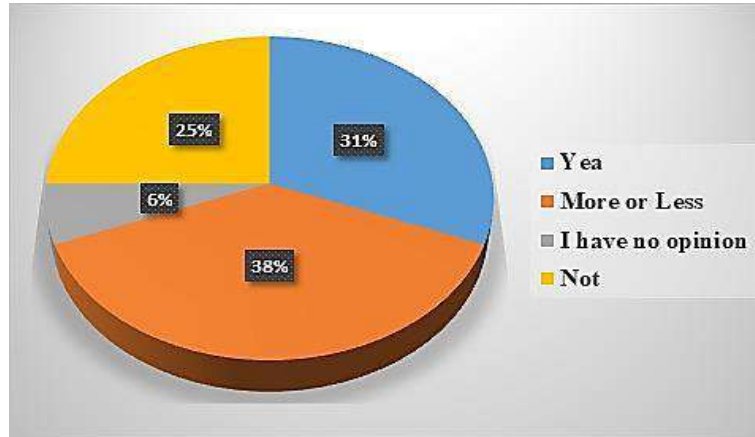


Fig. 2: Source: own Elaboration

Later, emphasizing the issue regarding the tasks that each play in the institution and your motivation to continue this performance. It was observed in graph 2 that a large majority (38%) employees do not have an opinion about what motivates them in your given function, (31%) claim

that the tasks that perform the motivate Yes, (6%) no opinion and a significant percentage (25%) declare that they are not satisfied.

Chart 3: do you consider the socially responsible company?

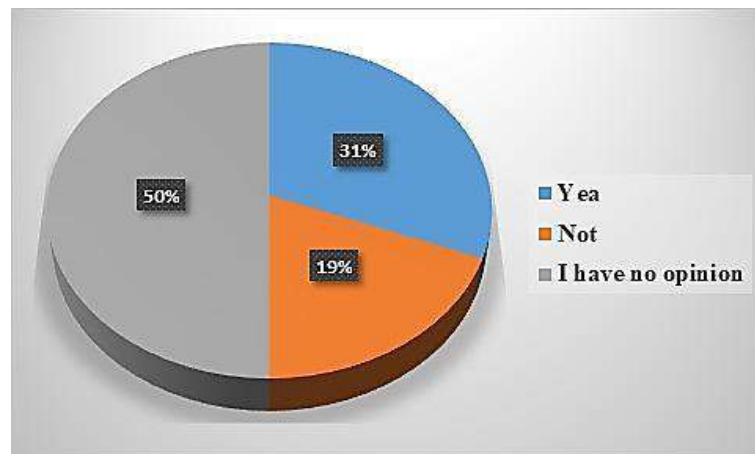


Fig. 3: Source: own Elaboration

Then we analyzed the opinion of employees regarding the responsibility of the institution they work for. The graph 3 indicates a result worthy of the greatest note, whereas half (50%) the collaborators do not have an opinion related to the company's social responsibility, followed by (19%)

who claim that the company has no social responsibility, and only (31%) claiming that company is responsible.

Chart 4: teamwork is encouraged by the company?

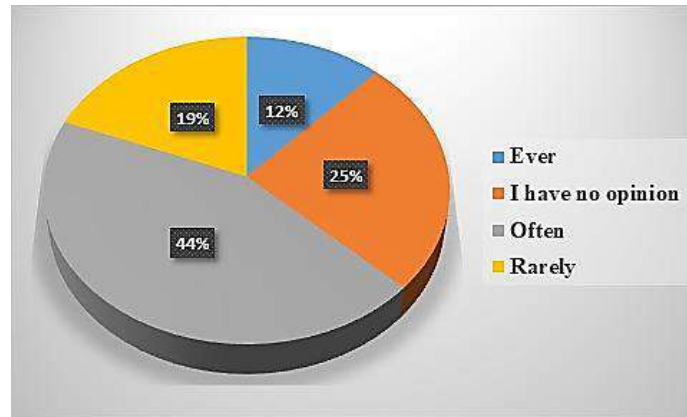


Fig. 4: Source: own Elaboration

On the assumption that teamwork is a very important feature within a company, graph 4 presents the vision of the developers about the company’s initiative to encourage teamwork. With this regard, (44%) the people responded

that almost always the company encourages, (25%) has no opinion, (19%) stated that rarely are encouraged and only (12%) stated that is always encouraged.

Chart 5: would indicate a friend to work in the company?

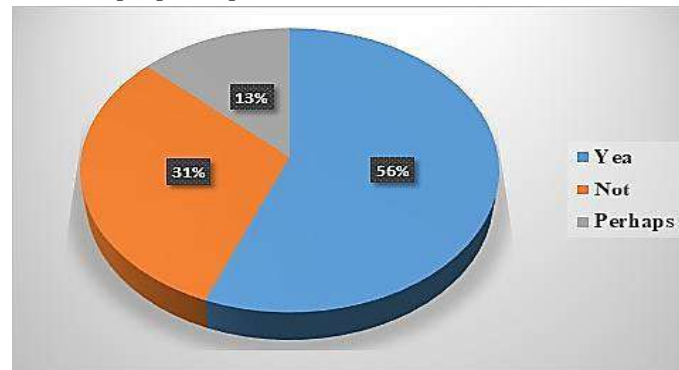


Fig. 5: Source: own Elaboration

According to the chart, a total of 5 (56%) employees would indicate for sure a friend to work at the institution, in contrast with (31%) that would indicate not only (13%) and stated that maybe would indicate. With this, note that in general employees like the workplace, even introducing some critical points the company where they work would still be an option for the workplace to a friend.

Finally, the employees questioned about suggestions that might be able to make the company a better place to work. Getting some solutions such as:

- Most replied that if there were more professional development programs and the environment would improve quality of life;
- Presented himself comments in relation to salary, which is still at a level below the coveted by officials;
- Finally, calling a lot of attention, recommended that the company should have less "politicking" and ego itself, thus the institution became a more harmonious and peaceful environment of work.

IV. CONCLUSION

Searches related to organizational climate have the as main aim to minimize conflicts between the needs of employees and enterprises because through this identifies dreams, desires, and needs of employees, and from then on measures may be taken, in order to achieve institutional objectives and meet the expectations. Aligning then the best individual and organizational goals.

The information obtained in this study should serve as the basis of the knowledge process for managers so that they are aware of the real situation in your organization today. Human needs often arise from a lack of motivation. The person who does not feel motivated little can engage or commit themselves to better carry out its commitments. An organization that should be considered a risk factor. The lack of human motivation can put on alert commitment and professional performance.

However, at the end of this work we can assess that there’s a lot of people happy and satisfied with your work and with the institution, more have several people who have that hint of contempt in relation to the development of the company.

REFERENCES

- [1] JESUS, M.; LEAL, S.; VIVAS, C. Percepções de clima, empenhamento organizacional e satisfação com o trabalho: um estudo de caso. Jornadas Luso-Espanholas de Gestão Científica, p. 1–14, 2010.
- [2] DA SILVA, G. A.; DE SOUZA, L. A. S. O IMPACTO CAUSADO PELO CLIMA ORGANIZACIONAL NO DESEMPENHO E NA QUALIDADE DE VIDA DA EQUIPE DE TRABALHO DO HOTEL HARDMAN-JOÃO PESSOA, PB. Revista Campo do Saber, v. 3, n. 1, 2017.
- [3] JOHANN SL. Gestão da cultura corporativa. [s.l.] Editora Saraiva; (2017).
- [4] OLIVEIRA, D. DE; CARVALHO, R. J.; ROSA, A. C. M. Clima organizacional: fator de satisfação no trabalho e resultados eficazes na organização. Simpósio de Excelência em Gestão e Tecnologia, v. 9, p. 02, 2012.
- [5] SANTOS, R. J. A. DOS. Clima organizacional: análise na visão dos colaboradores de uma instituição de ensino superior em Campina Grande - PB. 4 ago. 2017.
- [6] VERGARA, S.C. Projetos e relatório de pesquisa em administração. 8 ed. São Paulo: Atlas, 2007.
- [7] GIL, A.C. Como elaborar projetos de pesquisa. 4 ed. São Paulo: Atlas, 2007.

Structure and spatial distribution pattern of *Cyathea delgadii* Sternb. (Cyatheaceae) in two Cerrado areas, in the Northeast of Brazil

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Abstract— The research analyzed the population structure and spatial distribution pattern of individuals of two populations of *Cyathea delgadii* Sternb. (Cyatheaceae), occurring in Cerrado areas in the state of Maranhão/Brazil. The study areas are located in the East of Maranhão, in the Milagre village, municipality of Matões and in the Pedras Village in the municipality of São João do Sóter. In each area, seven contiguous plots of 30m x 10m (300m²) with 20m inter distribution between plots. Were sampled in the units all the individuals of *C. delgadii*, with height of the living caudex and diameter at the ground level (DNS). The height of the sampled individuals was distributed in classes and for analysis of the spatial distribution, the Morisita index and the variance/average ratio calculation were used. The statistical significance was verified through the Chi-squared. Were sampled 120 and 39 individuals in 100% and 90% of the plots in the Milagre and Pedras Villages, respectively, mostly in the first height classes (> 0-0,8m and > 0,8 - 1,6m). The distribution pattern of the two populations of *Cyathea delgadii* was aggregated with statistical significance. With the results are inferred some biotic and abiotic factors that can influence the distribution of *Cyathea delgadii* in its habitat and construction of its population niche. The data presented in the research made it possible to aggregate basic information for the management and preservation of this species in the Brazilian Northeast, contributing to the population knowledge of arborescent ferns.

Keywords— Pteridophytes, Maranhão plants, Ferns of thorns, Arborescent Ferns.

I. INTRODUCTION

The study of the characteristics of the populations of a specific species of plant is important for the understanding of its ecology, besides helping in the decision making in the planning and design of areas for the management and/or preservation (NASCIMENTO et al., 2002; HUBBELL; FOSTER, 1986). These studies serve as models for the species under study to determine how the environment is being exploited and how it responds to disturbances (OLIVEIRA et al., 1989).

A plant group that provides responses to environmental variations from ecological analyzes are Ferns and Lycophytes (PPG I, 2016), which refers to the group of vascular plants with great diversity of habits (Terrestrial, climbing, epiphytic, hemi-epiphytes,

rupicolous, xerophytes, halophytes, aquatics, floating and arborescent) (TRYON, 1989), with distribution influenced by the physical aspects of the environment (Types of substratum), soil texture, temperature, evapotranspiration, relative humidity and vegetative structure (TUOMISTO; POULSEN, 1996; ZUQUIM et al., 2007; POULSEN; NIELSEN, 1995; BERNABE et al., 1999; PACIÊNCIA; PRADO, 2005).

In Brazil, knowledge of the pattern of the spatial distribution of most species of ferns, as well as factors influencing them, is still little studied, which generates several knowledge gaps on the subject (MALLMANN et al., 2013). It is known that arborescent individuals can spatially distribute themselves in a randomized or uniform way and that a number of factors interfere in these

patterns of distribution (BROWER; ZAR, 1984). In the aggregate distribution, the progenies tend to be close to the parents and the individuals occupy the most favorable parts of the habitat; at random, individuals undergo different pressures or have restricted progeny distribution; and uniform, when there are negative interactions between individuals (eg, competition for food or space) resulting in uniform spacing between the specimens (RICKLEFS; MILLER, 2000; LUDWIG; REYNOLDS, 1988).

According to Ludwig and Reynolds (1988), environmental, reproductive, social, intraspecific and stochastic interactions are the main factors that can lead to various forms of distribution. Thus, knowledge about how individuals of a plant species distribute themselves in a community is one of the first steps to understand their population dynamics (HAY et al., 2000).

Among the species of arborescent ferns, *Cyathea delgadii* Stemb. (Cyatheaceae) is a very frequent group of the Brazilian Cerrado, with main diagnostic characteristics: a caudex with aculeous and fronds tapering, it is a terrestrial plant, that presents erect stem, with visible scars, petiole brownish, grooved, with aculeus and scales (HIRAI; PRADO, 2014). *Cyathea delgadii* occurs officially in Costa Rica, Panama, in South American countries around the Amazon basin from Guyana to Bolivia, in Brazil in all states except Amapá, Alagoas, Paraíba, Rio Grande do Norte and Sergipe

(HIRAI; PRADO, 2014, FLORA DO BRASIL 2020 EM CONSTRUÇÃO, CRIA, 2019).

In order to fill knowledge gaps in the pattern of spatial distribution associated with arborescent ferns, the research analyzed the population structure and the spatial distribution pattern of individuals of a population of *Cyathea delgadii* Stemb. (Cyatheaceae), occurring in two Cerrado areas in the state of Maranhão/Brazil.

II. MATERIAL AND METHODS

Areas of Study

The research was carried out in the East of Maranhão, in the rural areas of two municipalities, Pedras settlement in the municipality of Matões (05°36'04.08" S and 43° 11'56.79" W) (Figure 1).

The municipality of São João do Sótter extends for 1438.1 km², with approximately 150 villages, the village Pedras in the municipality is located to the margin of MA/127, that connects the municipality of Caxias to the municipality. The municipality of Matões has 2,107,403 km², with an estimated 33,615 residents in the last census carried out, adds the Milagre Village located inside the municipality. The villages have two well defined climatic seasons in the year, one rainy (between November to April, with the highest peaks in March) and another dry (drought period, especially between May to October) (IBGE, 2017).

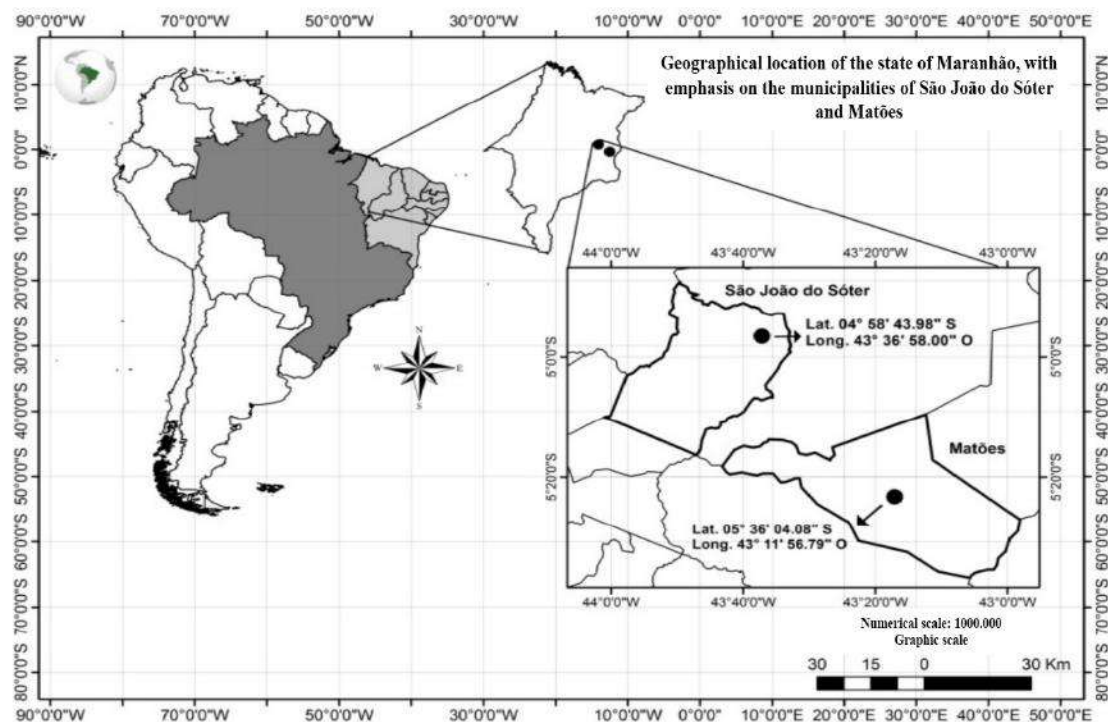


Fig.1: Characterization of the geographic area with Map with the geographical location of the collection areas (Milagre Village, Matões/MA, Pedras village, São João do Sótter, Maranhão/Brazil).

Data Collection and Analysis

For the sampling of the *Cyathea delgadii* (Figure 2) population, seven contiguous plots of 30m x 10m (300m²) were installed in each study area, parallel to the drainage line of the watercourse of the villages, with 20m

inter distribution, and the size of the species populations. In each plot, all individuals were sampled and recorded the heights of the living caudex and the diameter at the ground level (DNS).



Fig.2: *Cyathea delgadii*. A) Crosier; B) Fronde of the individual in adulthood; C) Apex of caudex with the presence of scales and thorns; D) Free vein and disposal of sori; E) Natural habit.

Each aerial caudate of *Cyathea delgadii* was considered an adult individual, using Schmitt (2005) sampling methodology. For the height measurement, an 8 m long track was used, for individuals with heights greater than 2 m, a graduated pole. For the measurements of the caudal diameters at ground level, a pachymeter was used.

The total number of individuals sampled was distributed in size classes with height intervals, according to Tanner (1983) and Schmitt (2005): 0 to 0.8m (Class 1), > 0.8 to 1.6m (Class 2), > 1.6 to 2.4m (Class 3), > 2.4 to 3.2m (Class 4), > 3.2 to 4.0m (Class 5), > 4.0 to 4.8m (Class 6), > 4.8 to 5.6m (Class 7), > 5.6 to 6.4m (Class 8).

In the analysis of the spatial distribution, the Morisita index (IM) ($IM = q \times \sum n(n-1) / N(N-1)$) was used, where q: number of plots sampled; n: and N (total number of individuals sampled) and the calculation of variance/mean ratio (R) (KREBS, 1989). Statistical significance was verified by the *Chi-squared* test ($X^2 = SS/X$, where SS: $(n-1)(s^2)$, n: number of plots studied, s^2 : variance of number of individuals, X: mean number of individuals). IM and R values less than 1.0 indicate random distribution, equal to 1 uniform distribution and greater than 1 pooled distribution.

III. RESULTS AND DISCUSSION

A total of 159 individuals of *Cyathea delgadii* were sampled in the two study areas. In the Milagre Village/Matões city, 120 individuals were sampled in the seven plots, equivalent to 2100 m², with an average of 17 individuals per plots. The number of

individuals ranged from one to 33 in the sampled plots. In the

Pedras Village/municipality of São João do Soter, 39 individuals were sampled in six plots, of the seven sampled, the population occupies the equivalent of 1800 m² of the study area, with a mean of 6.7 individuals per plots. The number of individuals ranged from four to 13 in the sampled plots (Figure 3). According to Harper (1990), one of the factors that determine the number of individuals in a population is the number of habitable sites, the resources available in the environment, numbers of germinated diaspores and the number of individuals in the reproductive phase. In the study areas, groupings of individuals of *Cyathea delgadii* were observed only in specific places, occurring in abundance in areas with greater availability of humid sites and with moderate canopy cover.

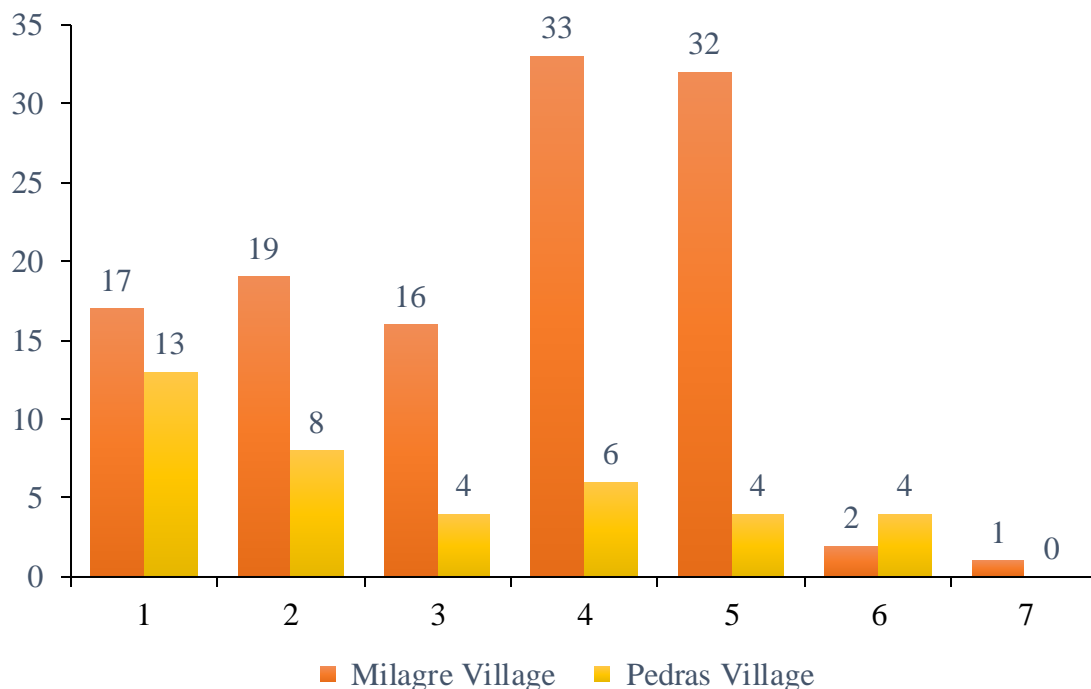


Fig.3: Number of *Cyathea delgadii* individuals by plots in the study areas, Maranhão / Brazil.

The behavior of the two populations of *Cyathea delgadii* is presented in aggregate form, confirmed by the Morisita index, as well as by the variance/mean ratio calculation

(Table 1). Statistical significance was verified using the *Chi-squared* values for the variance/mean ratio, as shown in the Table.

Table 1: Spatial distribution of *Cyathea delgadii* in the municipality of Matões/Milagre Village and in the municipality of São João Sóter/Pedras Village in the state of Maranhão/Brazil. R: variance /mean; I.M.: Morisita Index; df.: Degrees of freedom.

Area	Index	Values	Spatial distribution	df
Milagre Village	R	9.400*	Aggregated	6
	I.M	1.424*	Aggregated	6
Pedras Village	R	1.954*	Aggregated	6
	I.M.	1.126*	Aggregated	6

* values greater than 1.0 indicate an aggregated distribution

The tabulated values indicate that the population of *Cyathea delgadii* in the sampled units of Milagre Village Matões presents a higher aggregation pattern than the population sampled in the Pedras Village/São João do Sóter, which probably should be related to the structure of the areas. The population of *Cyathea delgadii* of Milagre Village/Matões shows a high frequency of the species due to the greater availability of moist and semi-shaded sites and being at a considerable distance from the anthropized fragments.

For the individuals of *Cyathea delgadii*, as well as for many species of arborescent ferns, the dispersion of spores is an important factor for their spatial distribution. Wolf et al. (2001), points out that easily the spores of the ferns can be dispersed by the wind at long distance, but Rosseto et al. (2005), states that plant species in which their diaspores are dispersed by the wind their distribution pattern presents in a random way, different from that found for *Cyathea delgadii*.

There are species of ferns that, by means of basal buds, form stolons, developing new individuals, reproducing themselves through ramifications of subterranean rhizomes (FERNANDES, 1997; LANGE and BRAINS, 2004). The populations of *Cyathea delgadii* in the studied areas compose a densification of young plants close to adult individuals in appropriate microhabitats for their development, suggesting that their reproduction can be carried out by ramifications of subterranean rhizomes, which may explain the pattern found and explain the difference to the suggestion of Rosseto et al. (2005). According to Begon et al. (2006), the aggregate distribution is due to conditions favorable to

the reproduction and survival of individuals, but other factors may influence this pattern of distribution, be they biotic, abiotic and/or anthropic (KERSHAW, 1973; MUELLER-DOMBOIS, ELLENENBERG, 1974; BARBOUR et al., 1987).

According to the descriptive analysis of the data, the minimum heights found in the areas of the Milagre/Matões Village and the Pedras Village/São João do Sóter respectively were 1.5 and 0.05 m, and the maximum of 6.1 and 2.1. The mean height was 1.2 m in the Milagre Village/Matões and 0.62 m in the Pedras Village/ São João do Sóter, results different from those reported by Schmitt and Windisch (2007), that present a mean height of 3.6 m.

The heights of the individuals were distributed in eight size classes. The two populations had the highest number of individuals in class 1, where Milagre Village had a total of 50 individuals and Pedras Village presented 30 individuals, followed by class 2 with 33 individuals in Milagre Village and 7 individuals in Pedras, Village Class 3, 25 and two individuals in the Milagre and Pedras Villages, respectively, in Class 4 the Populations Milagre Village presented eight individuals and no individual to the Pedras village and Classes 5, 6, 7, and 8 were distributed with only one individual in the Milagre Village and in the Pedras Village did not present individuals (Figure 4). The individuals are concentrated in the classes of lower height, evidencing that the population is growing, guaranteeing the maintenance of the population's survival (ANTONINI; NUNES-FREITAS, 2004).

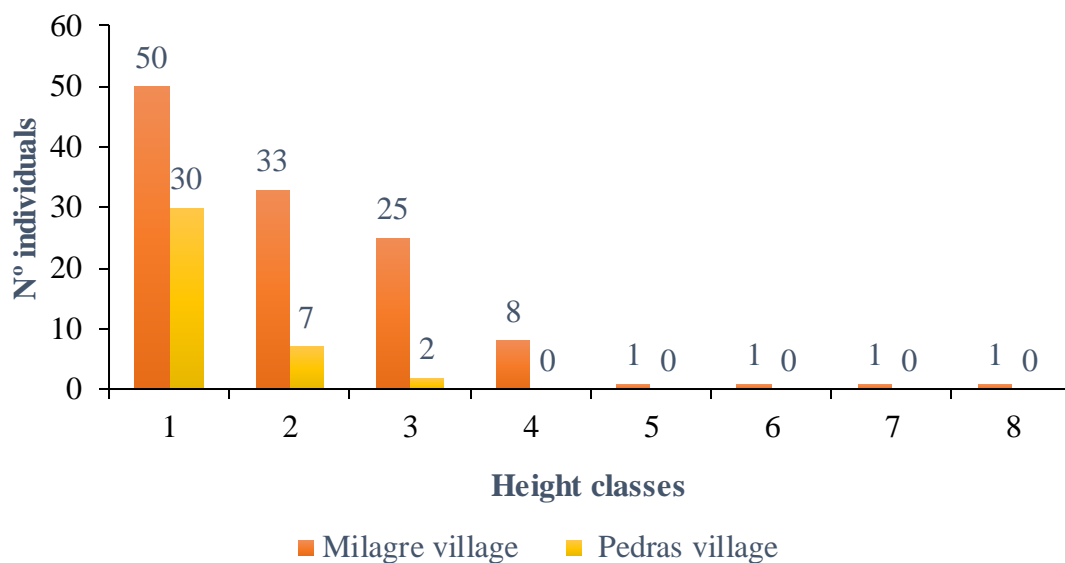


Fig.4: Distribution in height classes of the populations of *Cyathea delgadii* in the Municipality of Matões/Milagre Village and in the municipality of São João do Sóter/ Pedras Village in the State of Maranhão. Class 1:> 0-0,8m; Class 2:> 0,8a1,6m; Class 3:> 1.6 to 2.4m; Class 4:> 2.4 to 3.2m; Class 5:> 3.2 to 4m; Class 6:> 4 to 4.8m; Class 7:> 4.8 to 5.6m and Class 8:> 5.6m.

IV. CONCLUSION

The populations presented an aggregate distribution, thus, the data presented in this study provided basic and pioneering information for the management and preservation of this tree fern species in the East of Cerrado, Maranhão, in the Brazilian Northeast. It is expected that other researches will be carried out in the areas of studies to complement the presented results, such as anatomical studies and phenological behavior of the species, as well as, abiotic factors studies (soil analysis, soil water level, among others), since these studies will provide information on the development of the population in relation to the factors that surround them. Finally, the research contributed to the knowledge of the population structure of *Cyathea delgadii*, as well as its geographic distribution, since it had no record of occurrence for Maranhão.

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REFERENCES

- [1] Antonini R. D & Nunes-Freitas A. F. (2004). Estrutura populacional e distribuição espacial de *Miconia prasina* D.C. (Melastomataceae) em duas áreas de Floresta Atlântica na Ilha Grande, RJ, Sudeste do Brasil. *Acta Botânica Brasileira*, São Paulo, V.18, p. 671-676.
- [2] Barbour M.G, Burk J.H & Pitts W.D. (1987) **Terrestrial Plant Ecology**. 2 ed. Benjamin/Cummings, Menlo-Park.
- [3] Begon M, Harper J.L & Townsend C.R. (2006). **Fundamentos em Ecologia**. Porto Alegre: Artmed. 592p.
- [4] Bernabe N, Williams-Linera G & Palaciosrios M. (1999). Tree ferns in the interior and at the edge of Mexican cloud forest remnant: spore germination and sporophyte survival and establishment. *Biotropica*, v.31, p.83-88.
- [5] Brower J.E & Zar J.H. (1984). **Field and laboratory methods for general ecology**. Dubuque: Wm. C. Brower. 226p.
- [6] CRIA - Centro de Referência em Informação Ambiental. *Specieslink*. 2019. (smlink.cria.org.br). Acesso: 10/04/2019.
- [7] Fernandes I. **Taxonomia e fitogeografia de Cyatheaceae e Dicksoniaceae nas Regiões Sul e Sudeste do Brasil**. 1997. 435 f. Tese (Doutorado em Ciências), Universidade de São Paulo, São Paulo, SP, 1997.
- [8] Harper J.L. **Population Biology of plants**. Academic Press, London. 1990.
- [9] Hay J.D, Bizerril M.X, Calouro A.M.; Costa E.M.N, Ferreira A.A, Gastal M.A, Goesjunior C.D, Manzan D.J, Martins C.R, Monteiro J.M.G, Oliveira A.S, Rodrigues M.C.M, Seyffarth J.A.S & Walter B.M.T. (2000). Comparação do padrão da distribuição

- espacial em escalas diferentes de espécies nativas do cerrado, em Brasília, DF. **Revista Brasileira de Botânica**, v.23, p. 341-347.
- [10] Hirai R.Y&Prado J. (2014) Criptógamos do Parque Estadual das Fontes do Ipiranga, São Paulo, SP, Brasil. *Pteridophyta*: 3. Cyatheaceae. **Hoehnea**. v. 41, n. 2, p. 173-180.
- [11] HubbellS.P&FOSTERR. B. (1986)**Commonness and rarity in a neotropical forest: implications for tropical tree conservation**. In:SOULE, M. E. (ed.) *Conservation biology: science of scarcity and diversity*. Sunderland: Sinauer Associates Inc., p.205-231.
- [12] IBGE. **Censo 2000**. Instituto Brasileiro Geografia e Estatística. Disponível em: cidades.ibge.gov.br Acesso em: 10/04/2019.
- [13] Kershaw K.A. (1973). **Quantitative and dynamic plant ecology**. 2 ed. American Elsevier, New York.
- [14] Krebs C. J. (1989)**Ecological methodology**. New York, Harper & Hall, 654p.
- [15] LargeM.F&Braggins J. E. **Tree Ferns**. Timber Press. 2004, p. 359.
- [16] FLORA DO BRASIL 2020 em construção. **Lista de Espécies da Flora do Brasil**. Jardim Botânico do Rio de Janeiro. 2016. Disponível em: <http://floradobrasil.jbrj.gov.br/>. Acesso em 18 jan. 2016
- [17] LudwigJ.A&Reynolds J.F. **Statistical ecology: a primer on methods and computing**.John Wiley & Sons, New York, 1988.
- [18] Mallmann I.T, Rocha L.D&SchmittJ.L. (2013) Padrão de distribuição espacial de quatro espécies de samambaias em três fragmentos de mata ciliar do rio Cadeia, RS, Brasil. **Revista brasileira de Biociência**, Porto Alegre, v. 11, n. 2, p. 139-144.
- [19] Mueller-Dombois D, Ellenberg H. (1974).**Aims and methods of vegetation ecology**. John Wiley & Sons, New York.
- [20] Nascimento N.A, CarvalhoJ.O.P. & Leão N.V.M. (2002) Distribuição espacial de espécies arbóreas relacionada ao manejo de Florestas Naturais. **Revista Ciência Agrária** v.37, p.175-194.
- [21] Oliveira P.E.A.M, Ribeiro J.F& Gonzales, M.I. (1989) Estrutura e distribuição espacial de uma população de *Kyelmeyera coriacea* Mart. de cerrados de Brasília. **Revista Brasileira de Botânica** v.12, n.2, p.39-47.
- [22] Paciência M.L.B&Prado J.(2005)Effects of forest fragmentation on pteridophyte diversity in tropical rain forest in Brazil. **Plant Ecology**, v.180, p.87-104.
- [23] PPG I. A community-derived classification for extant lycophytes and ferns. **Journal of Systematics and Evolution**. v. 54, n. 6, p. 563-603, 2016.
- [24] Poulsen A.D& Nielsen I.H. How many ferns are there in one hectare of Tropical Rain Forest? **American Fern Journal**, v.85, p.29-35, 1995.
- [25] RicklefsR.E&Miller G.L. (2000)**Ecology**. 4ª ed. New York: WH Freeman and Company, 822 p.
- [26] RossetoV, Araújo J. S, Sfair J. C& Latini, A. O. (2005)**Avaliação da distribuição de espécies arbóreas em um fragmento de cerrado do município de Itapirapina, SP**, 13p. Disponível em: <http://www2.ib.unicamp.br/profs/fsantos/ecocampo/ne211/2005/R2-b.pdf>. Acessado em 20 abr. 2016.
- [27] Schmitt J. L. (2005)**Estudos florísticos, ecológicos e do desenvolvimento em Cyatheaceae (Pteridophyta) no Rio Grande do Sul, Brasil**. 2005. Tese de Doutorado. Universidade Federal do Rio Grande do Sul. Porto Alegre.
- [28] Schmitt J. L&Windisch P. G. (2007) Estrutura populacional e desenvolvimento da fase esporofítica de *Cyathea delgadii* Sternb. (Cyatheaceae, Monilophyta) no sul do Brasil. **Acta Botanica Brasilica**, n. 3.
- [29] Tanner E.V. J. (1983). Leaf demography and growth of tree-fern *Cyathea pubescens* Mett. Ex Kunh in Jamaica. **Botanical Journal of the Linnean Society**, v.87, p.213-227.
- [30] Tryon R. (1989)**Pteridophytes**. In: LIETH H.; WERGER M.J.A. (eds) *Ecosystems of the World 14b. Tropical Rain Forest Ecosystems. Biogeographical and Ecological Studies*. Elsevier, Amsterdam, The Netherlands, p. 327–338.
- [31] TuomistoH&Poulsen A. D. (1996) Influence of edaphic specialization on pteridophyte distribution in Neotropical Rain Forests. **Journal of Biogeography**, v.23, p.283-293.
- [32] WolfP.G, Schneider H&Ranker T.A. (2001). Geographic distributions of homosporous ferns: does dispersal obscure evidence of vicariance? **Journal of Biogeography**, v.28, p. 263-270.
- [33] Zuquim G, CostaF.R.C&PRADO, J. (2007) Fatores que determinam a distribuição de pteridófitas da Amazônia Central. **Revista Brasileira de Biociência**, v.5, n.2.

Hollywood Aesthetic Hegemony and forms of Resistance

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Abstract— *The aim of this paper is, in a first moment, to characterize what we are calling Hollywood aesthetic hegemony, through the blockbusters, to later realize how it affects its spectators in subjective scope. Next, we will identify different cinematographic movements, of different nationalities, - here we will work specifically the French Nouvelle Vague and the Danish Dogma 95 - that have in common a same search: an image policy that resists the spectacular and the standardization of sensations. We want to understand how the forms of resistance to this type of aesthetics, provided by another type of relationship with the images themselves, affect us transforming our sensitivity and with it our memory.*

Keywords— *Aesthetics, Cinema, Memory, Resistance, Subjectivity..*

I. INTRODUCTION

In 1895 the world of art would change forever through the presentation to the public of the first cinematographic images. The milestone of the public projection of cinema was in the *Indien Sólón* of the Grand Café in Paris, where the brothers Auguste and Louis Lumière present to the public, on December 28, 1895, the cinematograph - the forerunner of the projector. In this presentation the Lumière brothers exhibited the film "The arrival of the train to the station of La Ciotat", that entered the history of the cinema like one of its founding images causing great impact in the spectators, who could swear that a real train was coming towards them, not a projection of it.

We can say that a lot has changed since the first presentation of the cinematographic images and the films that make us go to the movies these days. From simple images, like a train coming toward you, we could see the birth of stories with complex characters and many narrative experiments. It was a long trajectory of aesthetic transformations along with transformations in our own society. For, as the philosopher Walter Benjamin noted, our sensibility and perception are historical, and are capable of going through variations at different historical times: "The era of the barbarian invasions, during which the artistic industry of the Lower Roman Empire and the Genesis of Vienna arose, had not only an art different from that which characterized the classical period, but also another form of perception" (BENJAMIN, [1936] 1994, p.169).

In the early years of the twentieth century, cinema "witnessed a series of successive reorganizations in its production, distribution and exhibition" (COSTA, 2006,

p.17), and also in its aesthetics, until it reached the stability that characterized classic Hollywood cinema - with its linear form of storytelling - between 1915 and the beginning of television in the 1950s, with the end of the so-called "the golden age". But even through a difficult period in the late 1950s, Hollywood still can still be considered the place that produces the most expensive and most profitable films in the film industry. Nowadays its main products are the famous Blockbusters, films under which we will clearly identify a hegemonic aesthetic standard that will be established in the course of the work.

We can say, in contemporary times, that both the artistic forms and the sensibility and perception of Western societies continue to change. We can also say that these transformations tend to be motivated, also, by the incessant technological advances that we have undergone since the end of the nineteenth century.

The aim of this paper is, in a first moment, to characterize what we are calling Hollywood aesthetic hegemony, through the blockbusters, to later realize how it affects its spectators in subjective scope. Next, we will identify different cinematographic movements, of different nationalities, - here we will work specifically the French Nouvelle Vague and the Danish Dogma 95 - that have in common a same search: an image policy that resists the spectacular and the standardization of sensations. We want to understand how the forms of resistance to this type of aesthetics, provided by another type of relationship with the images themselves, affect us transforming our sensitivity and with it our memory.

The idea of a hegemonic cinematography, within a circuit of production, distribution and exhibition carried out by the great North American entertainment corporations, especially the Hollywood majors, is only understood from a counterpoint perspective with the national cinematography's scattered around the world. And, through the cinema as a means of expression of an epoch, it is possible to see how the use of certain aesthetic forms affect the production of sensibility of a certain historical period, how strong the connection between sensitivity and memory is, and how they build, or impact, subjectivity.

II. THE HOLLYWOODIAN AESTHETIC HEGEMONY THROUGH THE BLOCKBUSTERS

In contemporary times, we quickly identify Hollywood's standard aesthetics through what we know as a blockbuster movie. Soon we think of movies with big budgets, big box office, big actors, that is, films that call our attention for its extravagance.

In the early 1970s the success of catastrophic films as such *The Poseidon Adventure*, 1972, by Ronald Neame and *Earthquake*, 1974, by Mark Robson, opened the doors for the studios to invest in a new cycle of films, a cycle that continues to this day with the blockbusters, which has its mark with the release of the film *Jaws*, 1975, by Steven Spielberg.

Justin Wyatt, in his book *High Concept: Movies and Marketing in Hollywood* (1994), defines the blockbusters as having the logic of today's multimedia conglomerates, which encompasses both the commercialization of the cinematographic image itself in various forms - from VHS to Blu-ray and nowadays reaching the streaming - until the commercialization of the greatest number of attainable items: soundtrack, games, clothes, toys, decoration items, different types of edits, etc. The plots, and its aesthetics, are idealized already thinking of hooks of marketing through the diverse medias. It is the economic surpassing the artistic.

In this "Hollywood conglomerate," the main product is the blockbuster. And the financial investment is so great - high cost caches and special effects; high number of copies and mass advertising - that even if there is a box office loss, which is a common thing, it is soon reversed in the "secondary display markets and related products" (MASCARELLO, 2006, p.349).

So far, we have realized that in relation to the economic aspect the blockbuster does not disappoint. But what about the artistic issue? What happens to other

filmic aspects, such as narrative, when the most valued issue is economic?

The Brazilian author Fernando Mascarello writes in an article called *Dick Tracy* the high concept film and Brazilian cinema (2005), that blockbuster, due to the predominance of market factors (such as the hiring of famous actors and marketing campaigns), ends up for sacrificing his narrative. This means that factors such as dramaturgical work - the art of composing and representing a story on the scene - and the characterization of the characters are left to second plane, or sometimes not even this, due to the spectacularization of the image.

According to the author, the narrative of the blockbuster is a simple narrative, not very significant and fragmented in modules, "characterized by a work of spectacularization or stylization that exceeds the requirements of the narrative" (MASCARELLO, 2006: 338). That is, it is predominantly a narrative of superficial character, modular and spectacular, not giving rise to a sophisticated plot.

Mascarello (2005, p. 70) says that this imbalance (in relation to the classic Hollywood balance) between the spectacle and the narrative occurs in contemporary times, undoubtedly, for an economic and industrial question. And because of the privileges to market, not artistic, factors, they are often Hollywood's most profitable films.

The Hollywood blockbusters are looking at a global market, and, on account of this, favor a standard aesthetic, extinguishing all the particular characteristics of a certain culture, such as regional forms and gestures, in order to a hegemonic model. Mascarello (2006, p. 335) says that this model is seen as an "aesthetic and sociocultural decadence". First, it weakens the narrative of the films; second, by the juvenilization of the audiences and third, the saturation releases of the blockbusters would result in a reduction to the spaces of exhibition of Brazilian films and international art films, fomenting a preference to the spectacle and the action in relation to the characters and dramaturgy, which would lead to lesser psychic investment by viewers. This entails restricting the creative thinking of the viewer. Its aesthetics is standardized in order to be consumed in all parts of the world, leaving no room for different types of interpretation of what is seen on the screen.

Due to the special effects currently available, such as 3D advancement, HD imaging and the dominance of robotic technology, contemporary blockbusters - such as *Avatar*, *Transformers* and *Jurassic World* - tend to create very realistic scenes in which we can hardly identify what actually exists and what is visual effect. In these

examples, everything is demonstrated through dialogues and exaggerated images: the screams, the explosions, the sound itself is very present and excessive leaving no loose ends, all actions and happenings are justified throughout the film.

That is, there is no place for any mystery or enigma. Nor are there subtleties or nuances, just the reality that is being violently imposed on human perception on the screen. The filmmakers appropriate an imaging technology and bring to us realities, of means of expression (images and sounds extremely realistic), ready and do not require interpretive efforts to make sense. Meaning is already given to us.

This would hinder our capacity for singularity, or rather, integrate the perceptions that we are subjected to our individual or collective memories. This means that Hollywood's hegemonic aesthetics would be hampering our ability to elaborate as experience (BENJAMIN, 1989) what we are seeing, in other words, would be hampering our ability to create meaning for ourselves through the image. Therefore, we are faced with a standardized form of thought that is fomented by Hollywood aesthetic hegemony.

On the other hand, there are still national movements interested in resisting this Hollywood industry. And as we shall see below, resistance will come from another quality of relationship with the images themselves.

III. NOUVELLE VAGUE AND DOGMA 95 AS RESISTANCE

Hollywood may now be the largest film industry on the planet, but it certainly is not the only film producer. We can identify different contemporary cinematographic movements, of different nationalities, having in common the same objective: an image policy that resists Hollywood's aesthetic hegemony. As an example, we can cite the new Asian cinema - and its directors Hayao Miyazaki, known for *The trip of chihiro* (*Sen to Chihiro no kamikakushi*, 2001, JAP), Naomi Kawase, known for *The Secret of Waters* (*Futatsumé no mado*, 2014, JAP), Apichatpong Weerasethakul, known as *Uncle Boonmee, Who Can Remember Their Past Lives* (*Loong Boonmee raleuk chat*, 2010, THA), among others - the films of German filmmaker Michael Haneke - known as *Caché* (2005, FRA, GER) and *The White Ribbon* (*Das weiße Band - Eine deutsche Kindergeschichte*, 2009, GER) - and even part of the work of American directors such as Gus Van Saint - *Elephant* (2003), *Last Days* (2005), *Paranoid Park* (2008) - and Sofia Coppola - *Lost in Translation* (2003) and *Somewhere* (2010). Here, we will focus on two cinematographic movements: the modern

French movement of the *Nouvelle Vague*. And a more contemporary one: the Nordic movement *Dogma 95*.

In fact, it is important to emphasize that resistance to Hollywood cinema is not a unique feature of contemporaneity. For this reason, we wanted to highlight *Nouvelle Vague*, a movement that produced ideas before producing films

At the beginning of the 1950s a group of young critics and intellectuals, known as young Turks, gathered or inspired by the magazine *Cahiers du cinéma* (founded by André Bazin, Jacques Doniol-Valcroze and Lo Luca) began a movement in France motivated, mainly, by discontent with the Hollywood big productions of the time commissioned by the great studios and the space they occupied in movie theaters all over France.

The young Turks, before beginning to produce their own films, developed through their articles the idea of the cinema of author, that is, the director as the author of a film. The concept that emerged looked at the author's thoughts, not the interests of the great studios, and especially his aesthetic style:

Nouvelle Vague's articles reveal the complex relationship between tradition and rupture, the contradictory equation that lies at the heart of his cinema and, in the end, of the other modern arts as well. What *Nouvelle Vague* sees in American cinema in terms of style procedures is often what he will do in his films, giving a reflective meaning to the assimilated forms. (MANEVY, 2006, p.227)

The counterproposal was more personal films "composing a self-critical observation of urban imaginaries, radical anthropology opposed to the vocation of" vulgarity and commerce "of cinema and the mythologies of consumer society" (MANEVY, 2006: 221). Writing itself was not enough for these young critics, so much that less than a decade after the birth of this "new wave," they began to venture into the world of images.

The passage from the cinematographic critique to its actual production was not of an hour to another. Its filmmakers have experimented a bit with short films, such as, *Les mistons* (1957), directed by François Truffaut, *Le coup du berger* (1956), directed by Jacques Rivette and *Tous les garçons s'appellent Patrick* (1959), directed by Jean-Luc Godard. In common they had a desire for creative autonomy, but each one portrayed their own personal and everyday issues. "The cinematic movement has brought to the screen the expectations and frustrations of a generation of young people matured in the Cold War, a post-war Europe without innocence, massed and overpopulated with images of cinema, advertising and

newly established television" (MANEVY, 2006, 222). Attached to this "new wave", or rather to the Nouvelle Vague, are well-known names in the world-wide cinematographic scene. Alain Resnais, Claude Chabrol, Agnès Varda, Chris Marker and Eric Rohmer are among the most famous, besides those listed before.

We can say that Nouvelle Vague had two moments, that of ideas and that of the movies. After the period of the short films, the feature film that inaugurated the movement was Claude Chabrol's film *Le Beau Serge* in 1958. Following are Chabrol's *Les cousins* in 1959 and François Truffaut's *The Misunderstood* (*Les quatre cents coups*, 1959).

The new cinematographic style, initiate mainly by Jean-Luc Godard and François Truffaut, would create conditions for a redefinition in the patterns and ways of filming established by the classic cinema:

The aesthetic conception of the Nouvelle Vague would allow for the intrusion, without further apology, of cartoons, movie archives, television programs, comics, documentary material, and other records from the narrative, plot or tonality of the scene in progress. We must not forget that the search for the street, in the case of Nouvelle Vague, had the solid formation of museums. It is in this dialectic between museum and street that the Nouvelle Vague is born (MANEVY, 2006, 245).

In classical narrative construction, the apparent techniques must fade in front of the story so that the viewer can feel as part of the film, for what matters is to transmit information in a linear way, guiding the viewer from a continuous narrative. Nouvelle Vague arises mediated by the values and concepts of modern art: the discontinuity, the incorporation of random and documentary reality, the valorization of the montage and the fragmented aesthetics. We can cite here the filmmaker Alain Resnais who was "an expert explorer of time relations, confusing references and breaking the stability of narration" (Manevy, 2006, 245), as he did for example in *Hiroshima, mon amour* (1959). The Nouvelle Vague explicit the existence of the narrator / narration, while the classic cinema aspires to a story that tells itself.

The end of this modern movement came in the late 1970s, influenced by the end of the friendship between its two greatest names: Godard and Truffaut. But it was not the differences between the two that caused the end of the friendship, but the political vision that Godard demanded of Truffaut after the revolution of May 1968. Godard "went through a process of intense politicization, putting in crisis the old politics of the authors, passing through a Maoist phase that would mark its most radical position in the 1970s as a modern and radically independent

filmmaker" (MANEVY, 2006, p.250). Truffaut did not share the same political position as his friend; in fact, he wanted to make more commercial films and never hid his desire to go to work in Hollywood, a desire that never materialized (MANEVY, 2006). This personal breakup established different aesthetic forms and cinematic visions for each director. With this, the movement itself came to an end. It is noteworthy that the Nouvelle Vague influenced other modern cinematographic movements, such as Brazilian Cinema Novo, Nuevo Cine Latin American and Portuguese Cinema Novo.

Having understood how the Nouvelle Vague was also a movement of resistance to Hollywood cinema of the time, let us focus, as already mentioned, on a specific contemporary movement to show how resistance to Hollywood film hegemony still exists. For in a world saturated by the incandescent light of the image in which the pattern is spectacular, by paying close attention we can see the faint glow of a cultural resistance that struggles more and more to appear, trying to escape the strong illumination that threatens its existence.

As part of this cultural resistance is the movement known as Dogma 95. This movement was presented in 1995 by Danish filmmakers Lars Von Trier, Thomas Vinterberg, Kristen Levring and Sören Krag-Jacobsen and became known for the radical asceticism of his manifest, composed of a series of rules that should be fulfilled by the directors so that their films could be recognized by the movement. For the most part, these rules sought to produce an economy of narrative means of expression, of visual, sound, and montage effects. Undoubtedly, an economy of form and a movement of abstinence, to the point that its members refer to their adherence to these rules as their "vow of chastity". It was then a strategy of resistance working by subtraction: its directors seek to produce a sobriety in narration and visual effects.

On the Danish manifesto we can say, first, that he "clearly defines a target of criticism: the Nouvelle Vague and the author's cinema. The text proclaims a rupture with the modern cinema that emanated from this movement, pointing out that the concept of author was a bourgeois romanticism from the beginning (...) "(HIRATA FILHO, 2012, 121). As a solution, the manifesto proposes a collective cinema that renounces authorship and proposes, from there, the definitive democratization of cinema.

Another point criticized for the manifesto is the illusory character of Hollywood commercial cinema. In this cinema, the manifesto identifies "an aesthetic capable of transmitting only an illusion of emotion and an illusion of love" (HIRATA FILHO, 2012, p 121), proposing, on

the other hand, the negation of artifices and illusion. Although we have seen that the Nouvelle Vague was also born as a criticism of Hollywood cinema, in Dogma 95 the intention is to "deny the modern first and point out a common root between it and the classic" (HIRATA FILHO, 2012, page 123) Hollywoodian. The common root would be the bourgeois origin of both.

Dogma 95 is an act of rescue in relation to the image prior to the spectacularization and hegemony of Hollywood sensations. In order to provoke sensations that are not determined a priori, the important thing is what is not said, that is, the intellectual participation of the spectator that occurs through the minimum information imposed by the image. That is, the opposite of the aesthetics of blockbusters as we saw earlier.

Three years after the launch of the manifesto debut Thomas Vinterberg's *The Celebration* (*Festen*, 1998), the first motion picture of the movement, or Dogma 1. It was followed by Lars Von Trier's *Idioten* (*Idioterne*, 1998), Dogma 2, and Mifune (*Mifunes sidste sang*, 1999) by Søren Kragh-Jacobsen, Dogma 3. The releases of the feature films have generated a lot of controversy among spectators and critics:

Some praised the Danish boldness to recover the idea of an extremely cheap and simple mode of production, which turned technical precariousness into poetic force. Others reject this same initiative, accusing the movement of being just a marketing blow, since they found in *Festen* echoes of previous aesthetic propositions, wrapped in what would be a false guise of innovation. (HIRATA FILHO, 2012, page 126)

Here we have no interest in getting into polemics. The point to be emphasized is not the commotion caused by the movement, in its debut, in the cinematographic milieu. What interests us is the complexity of the films through a simplified and singular aesthetic. Which is not to say simplistic, but rather uncomplicated, but at the same time very intense.

In this type of cinematic aesthetics, the viewer is always apprehensive and waiting for answers that never appear. We do not have any information other than what is being shown, in the present time, on the screen. There is no background and no justification for the actions of the characters. We see only the flash of what they would be. Few things are shown, and yet our feelings about these images are very strong, for we interpret them in a unique, particular way. The lack of answers, color and even soundtrack can also be articulated to this elusive and nothing spectacular image.

IV. FINAL CONSIDERATIONS

The effects on our sensibility, of the aesthetics proposed by the Nouvelle Vague, by the Dogma, as well as by other movements of resistance to the Hollywood hegemony, would be opposed to those that the spectacular spectacularization impinge to us. Our sensations would be awakened by images far from the clichés and that bring us a curious world, whose meanings we do not dominate, leaving us surprised. In this way, we would be displaced from the passivity to which we are subjected when we watch a film that intends to impose us an already defined interpretation. By doing this we would be able to create new and multiple meanings, thus being able to dissociate ourselves from a hegemonic standard imposed by the Hollywood industry.

In contemporary times, there is still a weak light resistant to this spectacular standardization. National, or independent, or rather non-standard artistic forms are there to prove this.

In fact, this would be the therapeutic function of cinema, proposed by the philosopher Walter Benjamin since the 1930s. For him, cinema could make us leave the state of alienation and numbness, awakening from anesthesia, to feel again. A cinema made to remove from the torpor:

Through its big takes, its emphasis on the hidden details of the objects that are familiar to us, and its investigation of the most vulgar environments under the genius of the objective, cinema makes us glimpse, on the one hand, the thousand conditions that determine our existence, and on the other assures us a great and unsuspected space of freedom. (BENJAMIN, 1994, p.189)

We would not need big revelations and / or big epiphanies for that. On the contrary. The intensity of the senses could arise in the small things of our daily life, generally from where we could least expect, as of simplicity and silence.

Critically thinking about cinema implies recognizing the social impact of this medium of communication and seeking to know the nuances of cinematic aesthetics and its ability to evidence or even create patterns of conduct that mark social boundaries or encourage transgressions of the status quo.

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REFERENCES

- [1] BENJAMIN, Walter. Sobre alguns temas em Baudelaire In Obras escolhidas, v. III. Charles Baudelaire um lírico no auge do capitalismo. São Paulo: Brasiliense. 1989. (P. 103-149).
- [2] BENJAMIN, Walter. (1936) A obra de arte na era de sua reprodutibilidade técnica In Obras escolhidas, v. I. Magia e técnica, arte e política. São Paulo: Brasiliense. 1994. (P. 165-196).
- [3] COSTA, Flávia Cesarino. Primeiro cinema in História do cinema mundial. MASCARELLO, Fernando (Org), Campinas, SP, Papirus. 2006.
- [4] HIRATA FILHO, Maurício. O Dogma 95 In BAPTISTA, M.; MASCARELLO, F. (Org.) Cinema mundial contemporâneo. Campinas SP: Papirus. 2012. (P. 121-136).
- [5] MANEVY, Alfredo. Nouvelle Vague In MASCARELLO, Fernando (Org.) História do cinema mundial. Campinas SP: Papirus. 2006. (P. 221-252).
- [6] MASCARELLO, Fernando. Dick Tracy, o filme high concept e o cinema brasileiro. Contracampo, Rio de Janeiro, n. 13, p. 69-82, 2005.
- [7] MASCARELLO, Fernando. Cinema hollywoodiano contemporâneo In História do cinema mundial. Campinas SP: Papirus. 2006. (P. 333-360).
- [8] WYATT, Justin. High concept: Movies and marketing in Hollywood. Austin: University of Texas Press. 1994.

Physico-Environmental Characterization of the Micro Basin Contributing to Fazenda Nova's (Goiás) Public Water Supply¹

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Abstract— A study of the physical and environmental characteristics of a river basin is crucial for advances in environmental management and plans aimed at managing and guaranteeing quality adequate to its use in the public water supply system. Hence, this study set out to undertake a physico-environmental characterization of the drainage basin of the Grande river, which contributes to supplying water to the municipality of Fazenda Nova, Goiás. The result could help monitor the availability and quality of the water and action for the recovery and preservation of areas at risk or degraded. The drainage area extended over 8.64 km² with a 14 km perimeter. The predominant soils in the hydrographic basin are Red Argisol and Quartzarenic Neosol. Morphometric characteristics, soil type, land use and cover and altimetry all indicate warning signals for physical and environmental quality. They also indicate that mitigating measures be undertaken, involving revegetation of land cover and the adoption of plans for land use and soil cover in the area under study.

Keywords— Morphometry; environmental quality; hydrographic basin.

Caracterização Físico-Ambiental Da Microbacia De Contribuição Ao Abastecimento Público De Fazenda Nova – Go

Resumo— O estudo das características físicas e ambientais de uma bacia hidrográfica é importante para o desenvolvimento da gestão ambiental e planos que visem o manejo e garantem a qualidade adequada para a sua utilização no sistema de abastecimento público de água. O objetivo deste trabalho foi a caracterização físico-ambiental da bacia hidrográfica do córrego Grande, que exerce contribuição ao abastecimento do município de Fazenda Nova, GO. O resultado será auxiliar na monitoração da disponibilidade e qualidade da água e ações de recuperação e preservação de áreas que apresentam riscos ou degradação. A área de drenagem encontrada foi de 8,67 Km² e 14 km de perímetro. O solo predominante na bacia hidrográfica é o Argissolo vermelho e o Neossolo Quartzarênico. As características morfológicas, tipo de solo, uso e cobertura da terra e altimetria indicam uma situação de alerta à qualidade físico-ambiental e para a adoção de medidas mitigadoras, reflorestamento da cobertura florestal e de adoção de planos de uso e cobertura do solo no local estudado.

Palavras-chave— Morfometria; qualidade ambiental; bacia hidrográfica.

I. INTRODUCTION

Water directly interferes with the life cycle of living beings and with the way of life of humans, in particular. Inadequate use of this hydro-resource has resulted in a gradual loss of water quality in sources, due

to increased sedimentation and more specially to changes in potability parameters for human supply. Anthropogenic activity on the biota and soil, with different uses and occupation has accelerated the process of water quality degradation, with economic and social consequences.

According to Coutinho *et al.* (2013), dynamic hydrological processes in basins could suffer considerable modification as a result of anthropic activities, such as changes in land occupation, deforestation, agricultural expansion and intensive urbanization. Therefore, alterations in the components of the river basin could interfere with the hydrological cycle and affect water flow, both qualitatively and quantitatively.

In Brazil, concern for the management and quality of water resources, and recognition of the need to preserve such a precious and vital asset, was highlighted for the first time in 1934, with the so-called Water Code, in Decree 24.543/34 (PIZELLA, 2015). With this, new policies emerged, such as the National Water Resources Policy (PNRH), the 1997 Law 9.433 (BRASIL, 1997). One of its principles establishes that the river basin is the territorial unit for implementation of the PNRH and for the action of the National System of Water Resource Management (SNGRH).

For Souza *et al.* (2014), it is crucial to identify water quality and verify its vulnerability to human activity, when one considers the need to conserve water resources. This contributes to its management without losing the perspective of analysis of the hydrographic basin. Therefore, monitoring the water resource is highly relevant, as the physico-environmental characterization of a basin can be used as a starting point for designing projects for a water supply system for human consumption and for monitoring and managing the quality and quantity of drinking water.

Coutinho (2013), Calilel *et al.* (2012) and Santos (2015) emphasize that characterization of the physical environment of the river basin, with a view to drawing attention to all critical areas from the point of view of water maintenance, is a basic condition for planning water conservation and the production of water, as are also land use and cover. For Pompermyer *et al.* (2016) and Santos (2015), therefore, spending on monitoring and planning for preserving the environmental quality of a river basin contributing to supply, generates beneficial economic returns, and maintains the availability and quality of drinking water.

With all of the above as a background, the aim of this study was the characterization and physico-environmental mapping of the Grande river micro basin, located in the municipality of Fazenda Nova, Goiás, with a view to qualifying it in terms of vulnerability, on the basis of the quality and availability of water for public supply of the municipality.

II. MATERIALS AND METHODS

The Grande river basin is a micro basin of the Araguaia river basin, which covers the midwestern region of the State of Goiás, located between the 50°47'10,34"W - 16°9'58,24"S and 50°47'38,84"W - 16°13'23,20"S coordinates (Google Earth Pro, 2017). The predominant climate in the region is tropical (Aw), according to the Köppen (1948) classification. The basin covers an area of 8.64 km² and presents a perimeter of 14 km. Red Argisol and Quartzarenic Neosol soils predominate in the region, according to data collected from the LAPIG geographical information site.

The Fazenda Nova micro basin was chosen for survey in this study because of its extension and also because it is a basin contributing to the municipality's public supply, as interference could affect the water needs of the population of the region.

According to Valle Junior *et al.* (2010), data of various types must be obtained through the supervised classification of images to survey the environmental quality in the basin, and the interference of physiographic characteristics, plant density and land use and cover in water quality and availability for supplying the region.

A Geographic Information System was used to organize and process the information obtained. Other instruments, such as Google Earth Pro and the TerraClassCerrado project collection were also used. The latter provides a series of geographic data about the Cerrado (Savannah), processed and organized into thematic maps from which shapefiles of the area can be downloaded and data for further analysis extracted. Therefore, the use of geographic information instruments was vitally important for the drafting of this project.

For the cartographic base, data collected in the virtual environments of geoinformation, such as the Laboratory of Image Processing and Geoprocessing (Lapig), State System of Geoinformation of Goiás (SIEG) and TerraClassCerrado. The data obtained, in shape format, were the drainage network of the Grande river basin, land use and cover, local geology, altimetry and hypsometry of the river basin and other characteristics which interfere with water quality and availability. These data were then processed, digitized and used in designing the maps using the Geographic Information Systems (GIS), Quantun Gis (Qgis) and Spring.

Following Bosquita *et al.* (2016), the quality of drainage of the micro basin was studied on the basis of density (Dd). This is a parameter for knowing the development of the drainage system, and it is obtained

by the ratio between the total length of the drainage network, including perennial and intermittent channels, and its total area (A). From this result, data which indicate the susceptibility of the micro basin to erosion can be obtained, by relating it to the results obtained from parameters, such as the surface runoff ramp length (RL) and the ruggedness index (RI), presented in Table 1.

Table 1. Description of morphometric parameters and their formulas. Adapted from Pinto et al. (2014).

Parameter	Formula	Description
Drainage density (Dd)	$Dd = \Sigma TL/A$	TL is the total length of all channels (km); A is the total drainage area (km ²).
Surface runoff ramp length (RL)	$RL = 1/4Dd$	Dd is the drainage density (km.km ⁻²).
Ruggedness Index (RI)	$RI = W * Dd$	W is the altimetric width of the basin (km); Dd is the drainage density (km.km ⁻²)

According to Pinto et al. (2014), the calculation of these parameters, with drainage density, results in the vulnerability of the micro basin to the surface erosion, presented in Table 2. Thus, with adaptations for the study of the micro basin, the calculation was made with the sum of weights which range from 5 (very high) to 1 (very low).

Table 2. Intervals for vulnerability analysis. Adapted from Pinto et al. (2014).

Interval – Result of addition	Degree of vulnerability to surface erosion	Vulnerability scale
From 3 to 5.4	Very low	1
>5.4 to 7.8	Low	2
>7.8 to 10.2	Average	3
>10.2 to 12.6	High	4
>12.6	Very high	5

After the review and analysis of satellite images, field observations were made in order to verify

the critical degradation points in the delimited area of the basin. The main focus of the on-site visit was an analysis of the main sources virtually located through Google Earth Pro. The sources confirmed were georeferenced and their coordinates are presented in Table 3. Evaluation of the sources (A, B, C, D, E and P) was conducted using studies by Belizário (2015) and Gomes et al. (2005) which present an analysis based on perception, observing characteristics such as vegetation, color and odor of the water, presence of residues and animals, and anthropic use.

Table 3. Coordinates of the location of the sources visited in the drainage basin of the Grande river, Fazenda Nova, Goiás. Google Earth, 2017.

Sources	Coordinates	
	Latitude	Longitude
Source A	-16.187299°	-50.782840°
Source B	-16.188053°	-50.783327°
Source C	-16.188669°	-50.784102°
Source D	-16.193747°	-50.781238°
Source E	-16.188592°	-50.786559°
Source F	-16.187830°	-50.789455°
Source G	-16.180925°	-50.791405°
Source H	-16.179129°	-50.791202°
Source I	-16.176589°	-50.793643°
Source J	-16.179311°	-50.802968°
Source K	-16.180037°	-50.804109°
Source L	-16.188073°	-50.799003°
Source M	-16.202059°	-50.797965°
Source N	-16.201019°	-50.792314°
Source O	-16.198799°	-50.785547°
Source P	-16.191417°	-50.778797°

The studies by Belizário (2015) and Gomes et al. (2005) on the quality of sources, use macroscopic parameters to obtain results which determine if the source falls within the quality categories ranging from “excellent” to “very bad”, as presented in Tables 4 and 5. The evaluation parameters received weights ranging from 1 to 3, which were added, and the result then served as a parameter for the qualitative classification of the source. The other sources were visually evaluated by means of processing and vectorization of the CNES/Airbus satellite images. However, in this case a maximum of possible parameters, such as proximity to homes, location and presence of preservation areas, was observed. This analysis could yield data on critical points in the micro basin.

Table 4. Classification of the quality of sources in terms of preservation. Adapted from Gomes et al. (2005).

Quality level	Score
Excellent	37 to 39 points
Good	34 to 36 points
Reasonable	31 to 33 points
Poor	28 to 30 points
Bad	Less than 28 points

Table 5. Weight and description of macroscopic parameters. Adapted from Gomes et al. (2005).

Parameters	Weight		
Color of water	1) Dark	2) Clear	3) Transparent
Odor	1) Strong	2) Weak	3) None
Refuse in the vicinity	1) Much	2) Some	3) None
Floating materials	1) Many	2) Some	3) None
Scum	1) Much	2) Some	3) None
Oil	1) Much	2) Some	3) None
Sewage	1) Present	2) Some	3) Absent
Vegetation	1) Serious degradation	2) Low degradation	3) Preserved
Used by animals	1) Presence	2) Only traces	3) Absent
Anthropic use	1) Presence	2) Only traces	3) Absent
Presence of PPA	1) Without protection	2) With protection (with access)	3) With protection (without access)
Proximity to homes	1) <50 meters	2) 50 to 100 meters	3) >50 meters
Type of ownership of the area	1) Absent	2) Private property	3) Parks or protected areas

Evaluation of the interference of land use and cover in the environmental vulnerability of the hydrographic basin was obtained by applying the study method proposed by Mota (2013) and Pinto *et al.* (2014). Their methodology consists of adopting weights for each type of land cover (Table 6). These were then multiplied by the area of occupation and the result divided by the area of the micro basin.

Table 6. Degree of vulnerability attributed to land use and cover units. Adapted from Pinto *et al.* (2014).

Land use/cover	Forest	Silviculture	Agroforestry	Pasture	Urban area
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Weight attributed	1	2	3	4	5
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III. RESULTS AND DISCUSSION

The Grande river micro basin presents a drainage extension of 13,436 km, and was classified as fourth order. Drainage density (Dd) in the area studied was 1.55 km.km², and characterized as a basin with good drainage, according to Bosquilha's (2016) classification, even though Calilet *al.* (2012) and Périco (2011) considered a density below 5 km.km² as low drainage.

If a river basin presents high density, this means that the soil is not very permeable. This could influence the occurrence of flooding and the transportation of soil particles to water bodies, according to Rocha and Kutz (2001). Thus, low drainage density means that the basin is less susceptible to erosion. The micro basin studied presents good density, which indicates that the soil has reasonable rain water infiltration capacity. But it should be noted that this parameter alone cannot be used as an indication of an area of low vulnerability. Périco *et al.* (2011) define drainage density as a parameter indicating the degree of development of the water system.

Ramp length (RL) is the slope of the terrain down to the river, in other words, the greater the slope the greater the transportation of soil particles and rainwater to the river. When compared to the 0.1751RL found by Pinto *et al.* (2014), who state that this value could influence soil loss, it could thus be affirmed that the slope of the micro basin of the Grande river, in relation to the main water body (0.771), could lead to the transportation of soil particles.

Ruggedness index (RI) yielded a value of 186. Higher and lower RI values represent higher and lower potential for erosion, respectively. This parameter is used to verify the suitability of the soil for certain uses and occupation. A study by Oliveira (2013) in the same region and biome as that studied here, produced a ruggedness index of between 17.7 and 27.2 for the Meia Ponte river basin, classifying it as having capacity for forestation only. This result is lower than that of 186 RI found in the Grande river micro basin. This shows the need for greater focus on the management and stewardship of the area. The same occurs in the physico-conservationist analysis of the subbasin of the Ibicuí river, Rio Grande do Sul (Sampaio *et al.*, 2010), which has an RI ranging from 0.565 to 4.428, which shows capacity for forestation in the sites with higher values.

The interaction of these three morphometric parameters gives the micro basin's degree of susceptibility to soil erosion. When compared with studies by Pinto *et al.* (2014) and Bueno *et al.* (2011), the result

of this interaction showed an average degree of vulnerability to surface erosion. In the pedological description of the micro basin, presented in Table 7, two soil profiles were described, Dystrophic Red Argisol, corresponding to approximately 88% of the area of the micro basin and Dystrophic Regolithic Neosol covering 12% of the area, represented in Figure 2. In the micro basin area, Red Argisol (PvD) predominates in an area presenting undulated relief with gravel and stones which, according to Calilet *et al.* (2013), are factors which accelerate surface runoff.

According to Araujo *et al.* (2004) and Santos (2013), the PvD unit presents low fertility (dystrophic) soils, characterized as being more susceptible to erosion, and also with low rates of water infiltration. As the Argisol is porous there is greater percolation and leaching of elements and low retention of pollutants, as is represented in Figure 1. Such factors contribute to and alert for areas subject to degradation and susceptibility to erosion, which suggests the need of conservation practices to prevent the transportation of sediments to the water body used for the region's public supply.

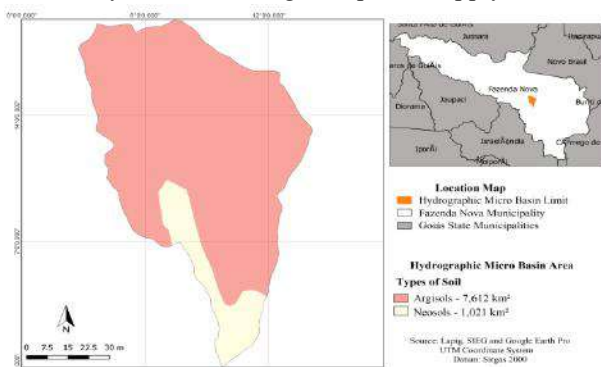


Fig.1. Map of the predominant soil profiles in the area studied.

Table 7. Survey of characteristics of soil types found (SIEG, 2013).

Class	Area	Characteristic	Relief	Vulnerability	Texture
Argisol	7,612 km ²	Gravelandstone	Undulating	2.2	Average/clay
Neosol	1,021 km ²	Sand	Undulating	2.8	Average

The altimetry of the region is 560 meters at its highest point and 400 meters at its lowest. Thus, its altimetric width yielded 160 meters, as presented in Figure 2. In comparison with studies by Reckziegel and Robaina (2006), the area of the micro basin can be

characterized from a slope between 14% and 27%, altimetric width greater than 100 meters and predominant altitude greater than 160 meters, with relief varying from undulating to steep. It can thus present hills and hillocks, which results in a process of surface dynamics of erosion to mass movements.

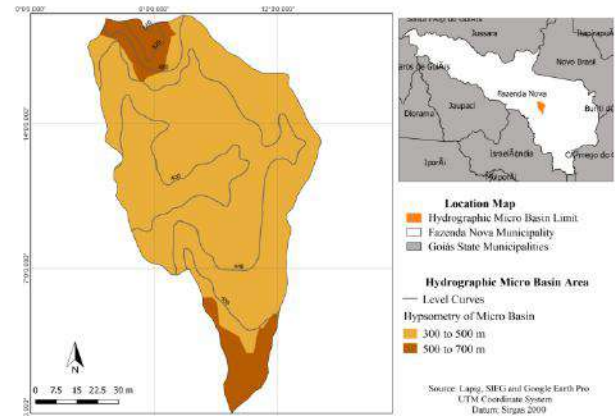


Fig.2. Map of the representation of level curves and hypsometry of the hydrographic micro basin.

In the micro basin, eighteen sources were mapped, as shown in Figure 4. From the field research, it was seen that of these, thirteen are perennial, and five (B, F, O, G, L) intermittent. During the temporal evaluation of the satellite images, some changes in location were observed. These are now more downstream, the result of deforestation in the region to make way for pasture. As a result of the mapping, representation of a drainage network was also extracted which was more complex (Figure 3) than those available in the SIEG and LAPIG sources. This difference is due to the use of a smaller scale to interpret the image features. Therefore, division of the hydrographic basin into a smaller scale (micro basin) helped obtain a better drainage network, covering all runoff stretches, whether perennial or intermittent.

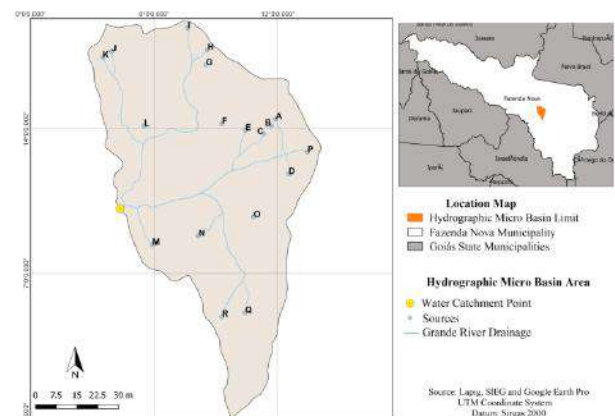


Fig.3. Map of source locations and drainage network in the micro basin of the Grande river on a scale of 1:10,000.

The field study helped with the location and evaluation of the environmental impacts of the sources. The macrocosmic parameters of the six main sources (A, B, C, D, E and P), presented in Figure 4, were evaluated according to Gomes’s (2005) previously presented method. Only one of the six sources was evaluated as “good”, while the others ranged from “very bad” to “bad”, as presented in Table 8. The other sources were not visited or analyzed as they showed a deficit in preservation area, where only five (J, M, K, Q and P) have a 50-meterradius of protective vegetation, as demanded by the Forestry Code (2012, Law 12651).

Carvalho (2000) emphasizes that riparian forests are of utmost importance for the protection of water resources, as the surrounding forest protects them against erosion, and consequently against silting. It also protects them against the arrival of agrochemicals and sediment and improves the physico-chemical and microbiological quality of the water. In this way, it is possible to evaluate how the lack of vegetation affects some of the sources visited, because without vegetation they are susceptible to pollution and external contamination.

Table 8. Environmental quality of sources – Macroscopic results.

Parameters	Sources					
	A	B	C	D	E	P
Water color	1	2	1	1	1	3
Odor	3	3	2	3	3	3
Refuse in vicinity	2	3	1	2	1	3
Floating materials	3	3	3	3	2	3
Scum	3	3	3	3	3	3
Oil	3	3	3	3	3	3
Sewage	3	3	3	3	3	3
Vegetation	1	1	1	1	1	2
Used by animals	1	1	1	1	2	3
Anthropic use	3	1	1	1	2	3
Presence of PPA	1	1	1	1	1	2
Proximity to homes	3	3	3	2	3	2
Type of owners in the area	1	2	1	2	1	3
Total score	28	29	24	26	26	36
Classification	Bad	Bad	Very Bad	Very Bad	Very Bad	Good

In the area under study, according to the Forestry Code, there should be a 30-meter stretch of PPA, along the total length of the Grande river, as it is less than 10 meters wide. And sources should have a 50-meterradius of PPA. It should have a total preservation area of 0.858 km² but has only 0.430 km². Therefore, public policies should be drawn up to control the use and cover of the micro basin, as a means towards preserving the availability of water at the source which supplies the town and preventing problems, such as water crises or a lack of drinking water.

Agriculture and cattle raising are predominant in the micro basin with an extensive area of pasture. However, as the soil is fragile and susceptible to erosion, most pasture land is very degraded. On analyzing the data on land use and cover in the micro basin, shown in Figure 4, it was seen that combined agriculture and cattle raising represents about 5,109 km², which corresponds to 59.13% of the total Grande river micro basin area. Native vegetation corresponds to 3,121 km², or about 36.12% of the total area while the urban area occupies 0.18 km², or 2.10% of the area.

The results of soil vulnerability in relation to land use and cover are presented in Table 9. According to Pinto *et al.* (2014), the result of the weighted area, divided by the total basin area of 2.95 could be considered level 3 or average in the scale of vulnerability to surface erosion, because in their analysis the values obtained from this same type of evaluation of the basin of the Espírito Santo river in Minas Gerais ranged from 2.89 to 2.84, which is medium vulnerability while from 3.44 to 3.97 represents high vulnerability.

Table 9. Determination of vulnerability in relation to land use and cover.

Unit of use/cover	Weight	Area of use/cover (km ²)	Weighted area (km ²)
Forest	1	3,121	3,121
Pasture	4	5.37	21.48
Urban area	5	0.18	0.9
Total weighted area (km²)			25,501
Total hydrographic basin area (km²)			8,671
Vulnerability			2.95

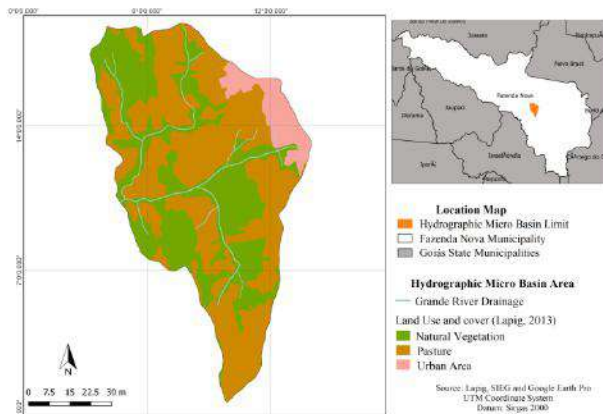


Fig.4. Map of land use and cover in the Grande river micro basin.

The land use situation in the micro basin is a result of deforestation of the Cerrado with a view to intensifying cattle raising, which is the basis of the economy in the region. Therefore, areas which should be destined for permanent preservation (PPA), such as river margins and land surrounding sources and springs, were transformed to accommodate the expansion in cattle raising. Hence, the calculation of areas destined for preserving river margins and sources in the basin yielded a deficit of 0.428 km² (Figure 5).

The deficit in forest area related to PPAs was detected in studies of drainage basins located in rural areas by Umetsuet *et al.* (2012) in Mato Grosso, Pomper Mayer *et al.* (2016) in the Federal District, Oliveira *et al.* (2013) in Goiás and Sampaio *et al.* (2010) in Rio Grande do Sul, by means of a study of physico-conservationist deterioration. However, the issues surrounding forest conservation in rural areas whether forest reserves or PPAs have not yet yielded the results expected with the promulgation of the July 18, 2000, Law 9985, National System of Conservation Units (BRASIL, 2000).

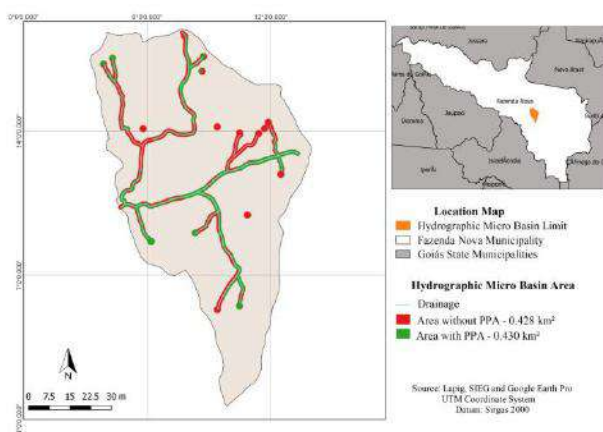


Fig.5. Representative map of the PPA deficit in the micro basin.

IV. CONCLUSION

In general, the Grande river micro basin presented medium vulnerability to erosion and critical environmental quality, influenced by the fact that a large part of the land is covered by pasture. The steep slope, soil type and the morphometric characteristic of the drainage area create an environment susceptible to degradation, thereby compromising the water supply to Fazenda Nova. Although drainage density was classified as good, the morphometric and land use and cover parameters were mainly responsible for the alarming result of the physico-environmental quality of the region.

Analysis of the physico-environmental characteristics in a GIS environment proved adequate for evaluating morphometric, topographic, land use and cover and quantitative parameters of the preservation areas of the Grande river micro basin. However, the study showed critical quality levels and an environment susceptible to erosion processes, thereby subjecting water bodies to silting, leaching and loss of drinking water quality.

The predominance of cover involving pasture and PPAs at a level of almost half of what there really should be in the riparian margins, and especially the very bad classification of the sources, where the majority do not have a preservation area of 50 meters, suggest the need to adopt mitigatory measures involving revegetation and the implementation of a stewardship plan for land use and cover and for water, in order to guarantee the qualitative and quantitative conservation of the water bodies supplying the region and control the growth of the agricultural and cattle raising activities.

REFERENCES

- [1] ARAUJO, M. A.; TORMENA, C. A.; SILVA, A. P. Propriedades físicas de um Latossolo Vermelho distrófico cultivado e sob mata nativa. *Revista Brasileira de Ciência do Solo*, Viçosa, v. 28, p. 337-345, 2004.
- [2] BELIZÁRIO, W. da S. *Análise Geoquímica e Ambiental das Bacias Hidrográficas dos Córregos Almeida e Santa Rita em Aparecida de Goiânia, GO*. 2015. 95 f. Dissertação (Pós-Graduação em Geografia) – Instituto de Estudos Socioambientais, Universidade Federal de Goiás, Goiânia. 2015.
- [3] BOLLMANN, H. A.; MARQUES, D. M. L. da M. Gestão Ambiental Integrada de Bacias Hidrográficas: Bacia do Rio Cachoeiras - São Mateus do Sul – PR. *Revista Brasileira de Recursos Hídricos*, Porto Alegre, v. 6, n. 3, p. 45-65, 2001.
- [4] BOSQUILIA, R. W. D.; FIORO, P. R.; DUARTE, N.; BARROS, P. P. da S. Diferentes imagens de satélite no mapeamento visual de drenagens e nascentes em

- amostras circulares. **Revista Interciência**, Caracas, vol. 41, n.5, pg. 25-259, 2016.
- [5] BRASIL. Ministério do Meio Ambiente. Lei nº 4.771, de 15 de setembro de 1965. Institui o Código Florestal Brasileiro. **Diário Oficial da República Federativa do Brasil**, Brasília, DF. 1965.
- [6] BRASIL. Ministério do Meio Ambiente. Resolução nº 303, de 20 de março de 2002. Dispõe sobre parâmetros, definições e limites de Áreas de Preservação Permanente. **Diário Oficial da República Federativa do Brasil**, Brasília, DF. 2002.
- [7] BUENO, C. R. P.; ARRAES, C. L.; PEREIRA, G. T.; CORA, J. E.; CAMPOS, S. Análise multivariada na determinação do risco de erosão em solos sob irrigação. **Revista Irriga**, Botucatu, v. 15, n. 1, p. 23-35, 2010.
- [8] BUZELLI, M. G.; CUNHA-SATINO, M. B. Análise e diagnóstico da qualidade da água e estado trófico do reservatório de Barra Bonita, SP. **Revista Ambiente & Água**, Taubaté, v.8, n.1, p. 186-205, 2013.
- [9] CALIL, P. M.; OLIVEIRA, L. F. C. de; KLEIMANN, H. J.; OLIVEIRA, V. A. de. Caracterização Geomorfométrica e do Uso do Solo da Bacia Hidrográfica do Alto Meia Ponte, Goiás. **Revista Brasileira de Engenharia Agrícola e Ambiental**, Campina Grande, v.16, n.4, p.433-442, 2012.
- [10] CARVALHO, P. E. R. **Técnicas de recuperação e manejo de áreas degradadas**. In: GALVÃO, A. P. M. Reflorestamento de propriedades rurais para fins produtivos e ambientais: um guia para ações municipais e regionais. Colombo: EMBRAPA-CNPQ, 2, p.19-55, 2000.
- [11] COUTINHO, L. M.; ZANETTI, S. S.; CECÍLIO, R. A.; GARCIA, G. de O.; XAVIER A. C. Usos da Terra e Áreas de Preservação Permanente (APP) na Bacia do Rio da Prata, Castelo - ES. **Revista Floresta e Ambiente**, Nova Iguaçu, v. 20, p. 425-435, 2013.
- [12] FIDALGO, E. C. C.; PRADO, R. B.; PEDREIRA, B. da C. C. G.; ARAÚJO, R. S. de. Caracterização e mapeamento do uso e cobertura da terra no COMPERJ, Estado do Rio de Janeiro, Brasil. **Embrapa Solos**. Boletim de Pesquisa e Desenvolvimento. Rio de Janeiro, 2011.
- [13] GOMES, P. M.; MELO, C.; VALE, V. S. Avaliação dos impactos ambientais em nascentes na cidade de Uberlândia – MG: Análise Macroscópica. **Sociedade & Natureza**, Uberlândia, v. 17, p. 103-120, 2005.
- [14] GUERRA, S. M. S.; SILVA, A. M. R. B. da; ARAÚJO, S. P.; CORRÊA, M. M.; SILVA, V. L. da; SANTOS, B. R. T. Caracterização Morfométrica e Avaliação da Qualidade da Água da Bacia Hidrográfica de Bita, Ipojuca – PE. **Revista Brasileira de Geografia Física**, Pernambuco, v.8, n3, p.759-775. 2015.
- [15] JÚNIOE, R. F. do V.; PISSARA, T. C. T.; PASSOS, A. de O.; RAMOS, T. G.; ABDALA, V. L. Diagnóstico das áreas de preservação permanente na bacia hidrográfica do Rio Tijucu, Ituiutaba - MG, utilizando tecnologia SIG. **Revista Agrícola**, São Paulo, v.30, n3, p. 495-503. 2010.
- [16] KOPPEN, W. **Climatologia: con un estudio de los climas de latierra**. México: Fondo de Cultura Económica, p.400. 1948.
- [17] MOTA, L. H. da S.; VALLADARES, G. S.; COELHO, R. M.; CRISCUOLO, C. Vulnerabilidade à Degradação dos Solos do município de Campinas, SP. **Revista Geografia**, Londrina, v.22, n.3, p. 65-79, 2013.
- [18] OLIVEIRA, L. F. C. de; CALIL, P. M.; RODRIGUES, C.; KLIEMANN, H. J.; OLIVEIRA, V. A. de. Potencial do Uso dos Solos da Bacia Hidrográfica do Alto rio Meia Ponte, Goiás. **Revista Ambiente & Água**, Taubaté, v.8, n.1, p. 222-238,2013.
- [19] OLIVEIRA, P. T. S. de; SOBRINHO, T. A.; STEFFEN, J. L.; RODRIGUES, D. B. B. Caracterização Morfométrica de Bacias Hidrográficas Através de Dados SRMT. **Revista Brasileira de Engenharia Agrícola e Ambiental**, Campina Grande, v. 14, n. 8, p. 819-825, 2010.
- [20] PÉRICO, E.; Cemin, G.; Arend, U.; Rempel, C.; Eckhardt, R. R. Análise fisiográfica da bacia hidrográfica do rio Forqueta, RS. In: Simpósio Brasileiro de Sensoriamento Remoto, 15, 2011, Curitiba, **Anais...** São José dos Campos: INPE, p.1200-1207, 2011.
- [21] PINTO, L. V. A.; ROMA, T. N. de; BALIEIRO, K. R. de C. Avaliação Qualitativa da água com Diferentes Usos do Solo em seu entorno. **Revista Cerne**, Lavras, v. 18, n. 3, p. 495-505, 2012.
- [22] PINTO, V. G.; LIMA, R. N.; RIBEIRO, C. B. de M.; MACHADO, P. J. de O. Diagnóstico físico-ambiental como subsídio a identificação de áreas vulneráveis à erosão na bacia hidrográfica do Ribeirão do Espírito Santo, Juiz de Fora (MG), Brasil. **Revista Ambiente & Água**, Taubaté, v. 9, n. 4, p. 632-646, 2014.
- [23] PIZELLA, G. D. A Relação entre Planos Diretores Municipais e Planos de Bacias Hidrográficas na Gestão Hídrica. **Revista Ambiente & Água**, Taubaté, v.10, n.3, p. 535-645, 2015.
- [24] POMPERMAYER, R.; ANGELO, H.; ALMEIDA, A. N. de. Custo Social da Degradação da Qualidade Hídrica para o Abastecimento Público. **Revista Floresta e Ambiente**, Nova Iguaçu, v. 23, n. 3, p. 320-329, 2016.
- [25] RECKZIEGEL, E. W.; ROBAINA, L. E. de S. Estudo de parâmetros morfométricos do relevo e da rede de drenagem da área situada entre os rios Jaguarí e Ibicuí no município de São Vicente do sul – RS. In: VI SIMPÓSIO DE GEOMORFOLOGIA. 2006. Goiânia.
- [26] ROCHA, J. S. M. KURTZ, S. M. J. M. **Manual de Manejo Integrado de bacias Hidrográficas**. Santa Maria: Editora da UFSM. 282 p. 2001.
- [27] SAMPAIO, M. V.; SANTOS, M. da S.; ROCHA, J. S. M. da; PAULA, M. D. de; MENDES, A. V. Deterioração Físico – Conservacionista da Sub-bacia Hidrográfica do Rio Ibicuí – Mirim – RS. **Revista Ciência e Agrotecnologia**, Lavras, v.34, n. 2, p. 300-306, 2010.
- [28] SANTOS, E. H. M. dos; GRIEBELER, N. P.; OLIVEIRA, L. F. C. de. Relação entre uso do solo e comportamento hidrológico na Bacia Hidrográfica do

- Ribeirão João Leite. **Revista Brasileira de Engenharia Agrícola e Ambiental**, Campina Grande, v. 14, n. 8, p. 826-834, 2010.
- [29] SANTOS, H.G. dos; JACOMINE, P.K.T.; ANJOS, L.H.C. dos; OLIVEIRA, V.A. de; LUMBRERAS, J.F.; COELHO, M.R.; ALMEIDA, J.A. de; CUNHA, T.J.F.; OLIVEIRA, J.B. de. **Sistema brasileiro de classificação de solos**. 3.ed. Brasília: Embrapa, p. 353, 2013.
- [30] SOUZA, M. M de; & GASTALDINI, M. do C.. Avaliação da qualidade da água em bacias hidrográficas com diferentes impactos antrópicos. **Revista Engenharia Sanitária e Ambiental**, Rio de Janeiro, v. 19, n. 3, p. 263-274, 2014.
- [31] UMETSU, R. K.; PEREIRA, N.; CAMPOS, E. F. de P. de; UMETSU, C. A.; MENDONÇA, R. A. M. de; BERNASCONI, P.; CAMARGO, M. F. Análise morfométrica e socioambiental de uma bacia hidrográfica Amazônica, Carlinda, MT. **Revista Árvore**, Viçosa, v. 36, n. 1, p.83-92, 2012.
- [32] ZUCCO, E.; PINHEIRO, A.; SOARES, P. A. Influência do Uso do Solo no Transporte de Cargas Anuais de Poluentes em Uma Bacia Agrícola. **Revista Brasileira de Recursos Hídricos**, Porto Alegre, v. 19, n. 2, p. 19-28, 2014.

Comparative Analysis of Multi-Storey RC Frame Building with and without Floating Column using Base-Isolation in Seismic Zone V

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Abstract— Earthquakes are the disturbances which occur deep inside the earth's crust they are felt in the form of trembling of earth, jolts, movements and with less or more destructive phase. Although true cause of earthquake is not so easy to determine but most fortunate part is that can be predicted to very much extent. In some cases they are not yet possible to forecast, they usually come without warnings. Which make it a matter of discussion, every year it affects human life with large scale of destruction which brings to the concern of many researchers to minimize its consequences. India is country which has seen devastating effects of earthquakes from pasts. It has many weak zones which are more prominent under its influence. As it is said life never stops many attempts are ongoing to overcome heavy risk which are making it boon to fight such natural activities. We know that development is an ongoing process which is unaware of such activities which greatly affects the infrastructure of a country causing huge economic losses. Tall buildings are standing globally all over the world. What if, if such tall structure with complex designs and irregularities such as irregular plan, asymmetric structure, Floating Columns, balconies, projections etc. hits an earthquake, it will abolish its existence. Therefore, it's very necessary to safeguard human life and property which is a primitive step. From there comes the methods to control. Various ways are there to stop drifts, displacement and minimizing shear values. Variety of static and dynamics method are there to study behavior of structure and conclude most preferable results. One such method is Base-isolation is a very fast-growing technique to isolate a building from ground accelerations and to restrict the structures against objectionable lateral forces.

The study uses a software method of dynamically analyzing a multi-storey modal structure as per Indian standards to know how much effective a base isolation method is when used in high seismic zone V.

Keywords— Floating column, Base-isolation, Etabs 2015, Response Spectrum Analysis.

I. INTRODUCTION

Natural disasters are the most unpredictable things which are mostly faced and are the biggest reasons for the creating huge catastrophe. Earthquake is one such calamity which are responsible for high level of devastating effects if venture unnoticed or give beyond the prediction. They are affecting the human lives and cause damage to property. It directly targets tall structures or buildings which are weak in design. The buildings which have irregularities in horizontal or vertical direction are the one who invites the most lateral forces, which show remarkable effects on them. They certainly affect the structures which are not designed as per the designed criteria. Floating column is an elemental member which are generally in demands or unavoidable due to some requirement criteria. They are also a part of

structure with geometric irregularity which may not be safe for structures especially in seismic zone. They act as a hanging member which start from slab or beam and lie on another beam which supports it. They do not lie on the ground as a normal column do, which differ them from general columns. When structures with floating column are present in seismic region the structure will undergo large shear displacement, story drift or torsional effects. Such structures are venerable to damages to seismic forces. Hence there is need of solution to such problems, one such solution is Base-isolation, they act as a mechanism whose work is to isolate a building from its base. It means between structure and base lies a material which has the flexibility to absorb the seismic frequencies which can harm the structure and can travel through the structure from the bottom to the top story.

II. LITERATURE SURVEY

Many researches have done with many calculated results, theories and graphical values. Every part is purpose fully done by all, providing variant answers in their analysis and case study. Some has good explanations and justification which have helped a lot to know more about the topic.

Sukumar Behera (2012)- He studied a multi-storey framed model by FEM (Finite Element Method), He changed the dimensional parameter to explain the variation in the values obtained for shear and torsion.

Ms Waykule (2017)- Software approach is applied for comparative study of the Floating column and brought that base shear in first floor decreases with use of floating column in place of without floating column.

Snehal Ashok Bhojar (2017)- Different locations of Floating column in the structures changes the behaviour of the especially its performance.

BhavanaBalachandra (2015)- The Software analysis is done by Etabs 2015 with use of Base isolated with LRB bearing. Base isolation reduces the vibrations moving upwards within the shaft of the building hence limiting the deflection causing parameters.

Swathirani K., Murlidhara G. (2015)- He compared various isolators with a fixed base building. HDRB is very much efficient then LRB as a bearing system in isolation technique. High values of damping ratio may reduce displacement in the buildings. Base isolation has come forward to the solution of many problems in zones of seismic intervention.

Gaurish Kumar Som (2017)- Modelled a G+5 building for case study to design LRB suitable for the building. He studied the response of the structure to various frequencies. By increasing damping percentage, it low down the values of time period.

Sharma R.K. (2016)- Analyzing an RCC framed structure using SAP 2000 having Floating column as a member. Floating column make load pattern distribution unbalance generate torsional effect causing building to twist and turn. It obtains more stiffness in each levels of the structure.

Rupali Goud (2017)- The result has much higher displacement values with floating member. Time history analysis give more lateral displacement than other methods of the dynamic analysis. Building experience more storey drift at each floor levels.

R.B. Ghodke (2015)- LRB isolator has been used as an isolation system in moment resisting frame using SAP 2000. Isolation act as aa absorbing material to absorb the energy coming from ground due to tectonic activities following with ground accelerations. It is a flexible

member to be good for tall structures but has strength to bear the weight of the structure without any failure. As height increases the displacement values increases with is lessened by isolating system as compared when isolating system not in use.

III. EXPECTED OUTCOMES AND NEED OF THE STUDY

One just can't bear the effect caused from the disasters, the humans are capable enough to find effective measures to minimize the risk of damage or injury caused. The technologies, new approaches and advancement in the field of science and instrumentation has helped a lot. It has served as a source to rescue for better sustainable living.

Problems are never ending and finding solutions is a continuous process. Need of study is not just limited to finding appropriate method to fight the existing problem but also it a method to make modifications to existing solutions more worthy. Finding cost effective ways as they may not prove to be pocket friendly when implemented on a large scale. Study also means predicting new problems which can arrive in front of us in future and ways to cope with it. Making the study easier with use of better tactics, knowledge, proper initial investment, experiences and merging various subjects and stream on an advance level.

Today also research is going on to timely determine the happenings or occurrences of earthquake but yet there is no such method to determine it. Building are yet standing tall although very much known to the effects it can cause to them. It is really a matter to study more about it and gathering as much knowledge to keep check on the misleading which it can cause.

The need here is to evaluate the behavior of structure and examine the forces coming over it. The nature or response a building shows to those developed forces. The pattern of modes it gives for various frequencies it shows at various time period. The resistibility of the structure to various load combinations.

IV. PROBLEM FORMULATION AND OBJECTIVE

The purpose of the study is to know how much difference a structure with floating column show as compared to structure without floating column. Determining the feasibility of the structure with floating column in severe seismic zone. How a soft story can be reason behind over all structure frame instability. Studying the shear force and bending moment values. Dynamic analysis is done to see inelastic deformations in the member. The aim here is

to determine base shear values, story displacement and check the torsion in structure. Studying cases of structure with floating and non-floating members. To know effectiveness of base-isolation system to bypass the vibrations reaching the structure's body. Comparative study of floating column member structure with no base-isolation and the structure with floating columns and base-isolation system together present in the same structure.

The software analysis for the dynamic analysis of the multi-storey RC Frame structure to determine the time period and frequencies of various mode shapes to the ground accelerations. Calculating maximum mass participation of the structure in which mode by the response spectrum using civil software.

V. CONCLUSION

The work done earlier gives very useful information obtained from the various methods of analysis performed on various types of structures both manually and software approach. These studies have helped a lot in making clarity to understand the subject. The study also promotes to widen the scope to the untouched parameters and topic on a broader scale. One can bring his results to the existing work done in the field, to development tremendous outcomes bringing more clarity to the concept.

1. The study so far says that floating columns are not a best choice to be incorporated in the multi-storey structure and when they are constructed in seismic zone it may prove to be poorer as they are the member making a building irregular. They can make building soft storey to bring more undesirable results.

2. More dimensional area is required for floating column and they require more ductile detailing for better distribution of loads. The position of floating column also matters a lot.

3. Storey drift and displacement increases due to vertical irregularity.

4. Base-isolation are the control method which confine a building against lateral forces which does not allow a building to undergo through vibration effects as the base isolation minimize them.

5. Use of base isolation to reduce the base shear values at the bottom of the structure.

REFERENCES

- [1] Rupali Goud (2017), 'Study of Floating and Non-Floating columns with and Without Earthquake, International Journal of Science Technology & Engineering, Volume 4, Issue 1, ISSN: 2349-784X.
- [2] A.P. Mundada and S.G. Sawadkar (2014), 'Comparative Seismic Analysis of Multi-storey Building with and without Floating Column', International Journal of Current Engineering and Technology, E-ISSN 2277-4106, P-ISSN 2347-5161.
- [3] Ms. Waykule, S.B. (2017), 'Comparative Study of Floating column of multi-storey building by using software', Int. Journal of Engineering Research and Applications, ISSN: 2248-9622, Vol. 7, Issue 1, (part 3), pp.31-38.
- [4] Shiwli Roy, Gargi Danda de (2015), 'Behavioural Studies of Floating Column on Framed Structures', International Journal of Research in Engineering and Technology, eISSN: 2319-1163, pISSN: 2321-7308.
- [5] Ms. Waykule. S.B., Mr. Kadam.S. S, Ms. Lale S.V (2016), 'Study of Behaviour of Floating Column for Seismic Analysis of Multi-storey Building', International Journal of Research and Technology (IRJET), eISSN: 2395-0056, p-ISSN: 2395-0072.
- [6] Snehal Ashok Bhojar (2017), 'Effect of Floating Column on Building Performance subjected to Lateral Load', VJER-Vishwakarma Journal of Engineering Research, Volume 1, Issue 2.
- [7] BhavanaBalachandra, Susan Abraham, 'Effect of Base Isolation in Multi-storeyed RC Building', ISOR Journal of Engineering (ISORJEN), ISSN(e): 2250-3021, ISSN(P): 2278-8719, Vol. 08, Issue 6, V(II), PP 84-93.
- [8] Swathirani.K. S, Murlidhara.G. B, Santoshkumar.N. B, 'Earthquake Response of Reinforced Concrete Multi Storey Building with Base Isolation', IJRET: International Journal of Research in Engineering and Technology, eISSN: 2319-1163, pISSN: 2321-7308.
- [9] Subramani, M. Shanmuganandam, 'Multistorey Residential Building with Base Isolation Method Using SAP', International Journal of Engineering and Technology.
- [10] Gaurish Kumar Som (2017), 'Performance Assessment of Base Isolated structures Against Seismic Loading', International Journal of Research & Technology (IJERT), ISSN: 2278-0181, Vol. 6, Issue 07.

Study on Wave Type at Water Wave Surface Equation Obtained from Kinematic Free Surface Boundary Condition (KFSBC)

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Abstract—In this research, water wave surface equation was formulated by integrating kinematic free surface boundary condition against time. Then, a study was conducted on the type of wave produced by the water wave surface equation.

Keywords—Integration of Kinematic Free Surface Boundary Condition, wave profile.

I. INTRODUCTION

Water wave surface equation of Airy water wave theory was formulated by working on small amplitude wave assumption (Dean (1991)) that produces sinusoidal wave which can be defined that wave height is two times the amplitude. Water wave surface formulation was done by working on Bernoulli equation on water wave surface with small amplitude assumption, so the water wave surface coincides with still water level. Then, KFSBC was done to formulate dispersion equation. Therefore, Bernoulli equation along with KFSBC can produce sinusoidal wave type.

In this research, water wave surface equation was obtained by integrating KFSBC against time without working on small amplitude wave assumption. In that water wave surface equation there are two wave constants that must be known their values, i.e. wave constant G and wave number k that are found in the velocity potential solution of Laplace equation. The equation to calculate those two variables was formulated using KFSBC and surface momentum equation. The characteristic of the produced water wave surface was studied using Wilson criteria (1963). Based on the criteria there are 4 (four) types of wave beginning with wave with the smallest amplitude, i.e. Airy's waves, Stoke's waves, Cnoidal waves and Solitary waves. In the deep water, the water wave surface equation that was obtained, produces 3 (three) types of the first wave, depending on the wave amplitude as the input.

II. THE FORMULATION OF WATER WAVE SURFACE EQUATION

Water wave surface equation will be formulated using velocity potential equation and KFSBC. Velocity potential equation of Dean (1991) is,

$$\Phi(x, z, t) = G \cos kx \cosh k(h+z) \sin \sigma t \quad \dots(1)$$

x is horizontal axis, z is vertical axis where $z = 0$ at the surface of still water level, t time, G wave constant, k wave number, $\sigma = \frac{2\pi}{T}$, angular frequency, T wave period and h still water depth. The equation was obtained by completing Laplace equation with variable separation method, where $\cosh k(h+z)$ is just a z function, so that $\frac{\partial \cosh k(h+z)}{\partial t} =$

$$\sinh k(h+z) \frac{\partial k(h+z)}{\partial t} = 0, \text{ thereby}$$

$$\frac{\partial k(h+z)}{\partial t} = 0 \quad \dots(2)$$

For all z value. For $z = \eta$, where $\eta = \eta(x, t)$ is the elevation of water surface with respect to still water level,

$$\frac{\partial k(h+\eta)}{\partial t} = 0 \quad \dots(3)$$

Equations (2) and (3) are called wave number conservation equation against time- t .

With the velocity potential, the equations of particle velocity horizontal- x direction and vertical- z direction can be obtained, sequentially as follows

$$u = -\frac{\partial \Phi}{\partial x} = Gk \sin kx \cosh k(h+z) \sin \sigma t \quad \dots(4)$$

$$w = -\frac{\partial \Phi}{\partial z} = -Gk \cos kx \sinh k(h+z) \sin \sigma t \quad \dots(5)$$

Particle velocity at water wave surface was obtained by substituting z with $\eta = \eta(x, t)$, where η is the elevation of water wave surface against still water level.

$$u_\eta = Gk \sin kx \cosh k(h + \eta) \sin \sigma t \quad \dots(6)$$

$$w_\eta = -Gk \cos kx \sinh k(h + \eta) \sin \sigma t \quad \dots(7)$$

Water wave surface equation was formulated by integrating KFSBC, $\gamma \frac{\partial \eta}{\partial t} = w_\eta - u_\eta \frac{\partial \eta}{\partial x}$ against time- t , . Substitute (6) and (7),

$$\gamma \frac{\partial \eta}{\partial t} = -Gk \sinh k(h + \eta) \cos kx \sin \sigma t$$

$$-Gk \cosh k(h + \eta) \sin kx \sin \sigma t \frac{\partial \eta}{\partial x} \quad \dots(8)$$

γ is weighting coefficient at weighted total acceleration equation with a value around 2.202-3.0. This research uses $\gamma = 2.483$ (Hutahaean (2019a-b)).

To make the writing easier, the following equations were defined

$$\beta_1(\eta) = \sinh k(h + \eta) \dots\dots(9)$$

$$\beta(\eta) = \cosh k(h + \eta) \dots\dots(10)$$

Substitute (9) and (10) to (8) and by multiplying the right side with $\frac{\sigma}{\sigma}$, then (8) becomes,

$$\frac{\partial \eta}{\partial t} = -\frac{Gk}{\gamma \sigma} \beta_1(\eta) \sigma \cos kx \sin \sigma t$$

$$-\frac{Gk}{\gamma \sigma} \beta(\eta) \sigma \sin kx \sin \sigma t \frac{\partial \eta}{\partial x} \dots\dots(11)$$

(11) was integrated against time- t by bearing in mind (3), i.e. $\text{at}z = \eta, \frac{\partial k(h+\eta)}{\partial t} = 0$ applies, which means that $\beta_1(\eta)$ and $\beta(\eta)$ have constant values against time t , thus the integration of the first term right side of the equation was completed by integrating $\sin \sigma t$,

$$\eta(x, t) = \frac{Gk}{\gamma \sigma} \beta_1(\eta) \cos kx \cos \sigma t$$

$$-\frac{Gk}{\gamma \sigma} \beta(\eta) \sigma \sin kx \int \sin \sigma t \frac{\partial \eta}{\partial x} dt$$

The integration of the second term right side of the equation will be completed using partial integration method, as follows

Assume a function of $f = \cos \sigma t \frac{\partial \eta}{\partial x}$. This $\cos \sigma t$ function was used so when it was differentiated against time t , $\sin \sigma t \frac{\partial \eta}{\partial x}$ will be formed, i.e.

$$\frac{\partial f}{\partial t} = -\sigma \sin \sigma t \frac{\partial \eta}{\partial x} + \cos \sigma t \frac{\partial^2 \eta}{\partial t \partial x}$$

This differential equation was multiplied with dt and integrated against time t ,

$$f = -\sigma \int \sin \sigma t \frac{\partial \eta}{\partial x} dt + \int \cos \sigma t \frac{\partial^2 \eta}{\partial t \partial x} dt$$

Substitute f and the first term right side was moved to the left and f was moved to the right and both equations were divided by σ ,

$$\int \sin \sigma t \frac{\partial \eta}{\partial x} dt = -\frac{1}{\sigma} \cos \sigma t \frac{\partial \eta}{\partial x} + \frac{1}{\sigma} \int \cos \sigma t \frac{\partial^2 \eta}{\partial t \partial x} dt$$

The integration of the second term right side of the equation can be completed the same way, but with an assumption that $\frac{\partial^3 \eta}{\partial t^2 \partial x}$ is a very small number, the integration can be completed by integrating just the $\cos \sigma t$ element.

$$\int \sin \sigma t \frac{\partial \eta}{\partial x} dt = -\frac{1}{\sigma} \cos \sigma t \frac{\partial \eta}{\partial x} + \frac{1}{\sigma^2} \sin \sigma t \frac{\partial^2 \eta}{\partial t \partial x}$$

Substitute the result of integration,

$$\eta(x, t) = \frac{Gk}{\gamma \sigma} \beta_1(\eta) \cos kx \cos \sigma t - \frac{Gk}{\gamma \sigma} \beta(\eta) \sin kx \sin \sigma t \left(-\cos \sigma t \frac{\partial \eta}{\partial x} + \frac{1}{\sigma} \sin \sigma t \frac{\partial^2 \eta}{\partial t \partial x} \right)$$

Working on an assumption that $\frac{1}{\sigma} \sin \sigma t \frac{\partial^2 \eta}{\partial t \partial x}$ is a very small number and can be ignored,

$$\eta(x, t) = \frac{Gk}{\gamma \sigma} \beta_1(\eta) \cos kx \cos \sigma t + \frac{Gk}{\gamma \sigma} \beta(\eta) \sin kx \sin \sigma t \cos \sigma t \frac{\partial \eta}{\partial x}$$

The equation was differentiated against horizontal- x axis.

$$\frac{\partial \eta}{\partial x} = -\frac{Gk}{\gamma \sigma} \beta_1(\eta) k \sin kx \cos \sigma t + \frac{Gk}{\gamma \sigma} \beta(\eta) k \cos kx \sin \sigma t \cos \sigma t \frac{\partial \eta}{\partial x} + \frac{Gk}{\gamma \sigma} \beta(\eta) \sin kx \sin \sigma t \cos \sigma t \frac{\partial^2 \eta}{\partial x^2}$$

or

$$\frac{\partial \eta}{\partial x} = \left(-\frac{Gk}{\gamma \sigma} \beta_1(\eta) k \sin kx + \frac{Gk}{\gamma \sigma} \beta(\eta) k \cos kx \sin \sigma t \frac{\partial \eta}{\partial x} + \frac{Gk}{\gamma \sigma} \beta(\eta) \sin kx \sin \sigma t \frac{\partial^2 \eta}{\partial x^2} \right) \cos \sigma t \dots\dots(12)$$

In accordance with the provision at the velocity potential equation where there is t function only, x function only and z function only, then at the water wave surface using variable from velocity potential equation, water surface equation also has variable that is t function only and x function only, so it can be stated that the general form of (12) is,

$$\frac{\partial \eta}{\partial x} = f(x) \cos \sigma t$$

In this equation $f(x)$ is just a function of x . $f(x)$ in (12) is,

$$f(x) = \left(-\frac{Gk}{\gamma\sigma} \beta_1(\eta) k \sin kx + \frac{Gk}{\gamma\sigma} \beta(\eta) k \cos kx \cos \sigma t f(x) + \frac{Gk}{\gamma\sigma} \beta(\eta) \sin kx \cos \sigma t \frac{df}{dx} \right)$$

Bearing in mind (3) $\beta_1(\eta)$ and $\beta(\eta)$ should be constant numbers against time t and against horizontal x axis. In the second and third terms right side of the equation there is a function of time t , i.e. $\cos \sigma t$, then the term shouldn't be there. Therefore $f(x)$ is,

$$f(x) = -\frac{Gk}{\gamma\sigma} \beta_1(\eta) k \sin kx$$

Thereby

$$\frac{d\eta}{dx} = -\frac{Gk}{\gamma\sigma} \beta_1(\eta) k \sin kx \cos \sigma t$$

Substitute this equation to (11),

$$\frac{d\eta}{dt} = -\frac{Gk}{\gamma\sigma} \beta_1(\eta) \sigma \cos kx \sin \sigma t + \left(\frac{Gk}{\gamma\sigma} \right)^2 \beta(\eta) \beta_1(\eta) \sigma k \sin^2 kx \sin \sigma t \cos \sigma t$$

is integrated against time t . Integration will be completed by bearing in mind wave number conservation equation (3), as in the previous section, thus integration was done by integrating only sinusoidal element and bearing in mind that $\sin \sigma t \cos \sigma t = \frac{1}{2} \sin 2\sigma t$,

$$\eta(x, t) = \frac{Gk}{\gamma\sigma} \beta_1(\eta) \cos kx \cos \sigma t - \frac{1}{4} \left(\frac{Gk}{\gamma\sigma} \right)^2 \beta(\eta) \beta_1(\eta) k \sin^2 kx \cos 2\sigma t$$

..(13)

To determine the values of $\beta_1(\eta)$, $\beta(\eta)$, an approach was done that water surface equation is sinusoidal, i.e.

$$\eta_0(x, t) = A \cos kx \cos \sigma t \dots\dots(14)$$

Therefore, the approach of hyperbolic function is $\beta_1(\eta) = \beta_1(\eta_0)$, $\beta(\eta) = \beta(\eta_0)$.

$$\eta(x, t) = \frac{Gk}{\gamma\sigma} \beta_1(\eta_0) \cos kx \cos \sigma t - \frac{1}{4} \left(\frac{Gk}{\gamma\sigma} \right)^2 \beta(\eta_0) \beta_1(\eta_0) k \sin^2 kx \cos 2\sigma t$$

..(15)

III. THE CALCULATION OF G AND k

To calculate G and k , two equations are needed, i.e. KFSBC and surface momentum equation.

By working on (14) on (11),

$$\frac{d\eta_0}{dt} = -\frac{Gk}{\gamma\sigma} \beta_1(\eta_0) \sigma \cos kx \sin \sigma t$$

$$-\frac{Gk}{\gamma\sigma} \beta(\eta_0) \sigma \sin kx \sin \sigma t \frac{d\eta_0}{dx}$$

At the characteristic point, i.e. at $\cos kx = \sin kx = \cos \sigma t = \sin \sigma t$, the equation becomes,

$$A = \frac{Gk}{\gamma\sigma} \beta_1 \left(\frac{A}{2} \right) - \frac{Gk}{\gamma\sigma} \beta \left(\frac{A}{2} \right) \frac{kA}{2} \dots\dots(16)$$

Surface momentum equation where convective acceleration term is ignored is,

$$\gamma \frac{d^2 u_\eta}{dt} = -g \frac{d\eta_0}{dx} \dots\dots(17)$$

At the characteristic point, where $\frac{d^2 u_\eta}{dt}$ was obtained from (6) equation $\gamma \sigma G \beta \left(\frac{A}{2} \right) = gA$ was obtained

or,

$$G = \frac{gA}{\gamma \sigma \beta \left(\frac{A}{2} \right)} \dots\dots(18)$$

Substitute (17) to (15),

$$\gamma^2 \sigma^2 = gk \tanh k \left(h + \frac{A}{2} \right) - \frac{gk^2 A}{2} \dots\dots(19)$$

was obtained. In the deep water, $\tanh k \left(h + \frac{A}{2} \right) = 1$, then dispersion equation in the deep water is,

$$\gamma^2 \sigma^2 = gk - \frac{gk^2 A}{2} \dots\dots(20)$$

This equation is quadratic equation of wave number k where k can be calculated using simple method, i.e. finding the square root. Therefore, the calculation of G and k was done by calculating k with (20) and then G was calculated with (18).

As an illustration of the result of the calculation, wave length at L was calculated where $L = \frac{2\pi}{k}$, for wave with wave period of 8 sec., wave amplitude 0.6 m, 0.8 m and 1.0 m. The result of calculation, shown on Fig. 1 shows that there is an impact of wave amplitude on wavelength, i.e. the bigger the wave amplitude, the shorter the wavelength.

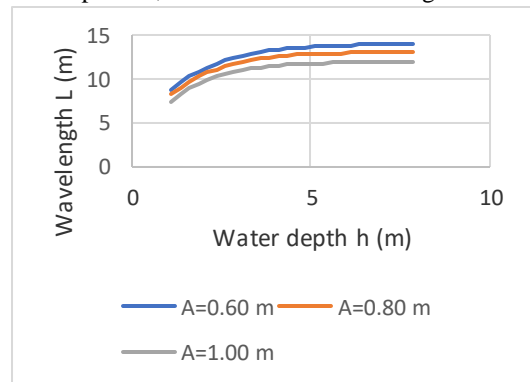


Fig.1. The impact of wave amplitude A on wavelength $L = \frac{2\pi}{k}$

In (20), there is a maximum value of wave amplitude, i.e. when determinant value $D = g^2 - 4\left(\frac{gA}{2}\right)(\gamma^2\sigma^2) = 0$. In this condition wave amplitude $A = A_{max}$, with the value, $A_{max} = \frac{g}{2\gamma^2\sigma^2}$ (21)

At wave amplitude maximum where determinant = 0, wave number becomes

$$k_0 = \frac{1}{A_{max}} \quad \text{.....(22)}$$

In the deep water $\tanh k_0 \left(h_0 + \frac{A_0}{2}\right) = \tanh k_0 h_0 \left(1 + \frac{A_0}{2h_0}\right) \approx \tanh k_0 h_0 = 1$. Consider $\frac{A_0}{2h_0} \ll 1$.

where $\tanh(1.65\pi) = 0.999937$. Then deep water depth $h_0 = \frac{1.65\pi}{k_0} = 1.65\pi A_{max}$ (23)

The use of coefficient 1.65 in (23) is the result of breaker depth calibration in shoaling-breaking model against breaker-depth from SPM(1984). The model is not discussed here.

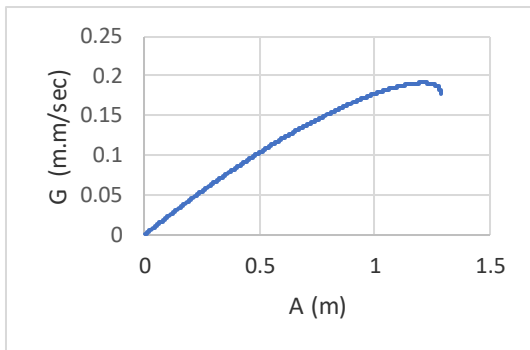


Fig.2. Graph of the value of G as a function of wave amplitude A

Fig.2 shows graph of value G as the function of wave amplitude, for wave with wave period of 8 sec in the deep water. It shows that the value of G grows bigger as the wave amplitude grows bigger, but there is a wave amplitude value where G reaches maximum value, i.e. the value of G decreases as wave amplitude grows bigger, until it has negative value at wave amplitude equals to A_{max} . There is a similar phenomenon for other wave period, where G_{max} was achieved at wave amplitude of $0.91 A_{max}$. Therefore, for a wave period, the wave amplitude value that should be used is

$$A_{max} = \frac{0.91g}{2\gamma^2\sigma^2} \quad \text{.....(24)}$$

In (22) and (23) A_{max} was used in (24). Bearing in mind (3), the calculation of wave number k for a wave moving from a certain depth to another depth cannot be calculated with (19), it should be with wave number conservation law. The

result shown on Fig.1. should be read as a wave with wave constant values G and determined wave amplitude. Therefore, Fig.1. is not the value of wave amplitude k moving from deep water to shallow water.

IV. TYPE OF WAVE PRODUCED BY WATER WAVE SURFACE EQUATION

4.1. General Shape

The general shape of water wave surface produced by (15) is shown on fig.3. The shape of water wave surface is not symmetrical between wave crest and wave trough where $\eta_{max} > |\eta_{min}|$, η_{max} is the elevation of wave crest above still water level (line of elevation $z = 0$), whereas η_{min} is the elevation of wave trough below line $z = 0$. Wave profile like this is called cnoidal wave profile (Wilson(1963)). With wave height $H = \eta_{max} - \eta_{min}$.

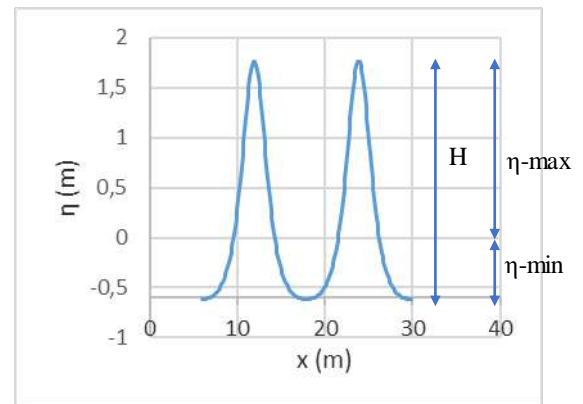


Fig.3. General shape of water wave surface.

4.2. Wilson Criteria (1963)

Wilson (1963) classified wave type based on the value of $\frac{\eta_{max}}{H}$. Airy waves or sinusoidal waves types have a value of $\frac{\eta_{max}}{H} < 0.505$. This shows that the shape of wave is symmetrical, where $\eta_{max} \approx |\eta_{min}|$. Type Stoke's wave type is still quite close with the sinusoidal character. Furthermore, cnoidal waves type is not symmetrical at all where there is a form of wave with the wave trough that almost coincides with the line $z = 0$ i.e., where $\frac{\eta_{max}}{H} \approx 1.0$. This type of wave is called solitary waves type.

Table.1: Wilson criteria (1963)

Wave Type	$\frac{\eta_{max}}{H}$
Airy waves	< 0.505
Stoke's waves	< 635

Cnoidal waves	$0.635 < \frac{\eta_{max}}{H} < 1$
Solitary waves	$= 1$

4.3. Sinusoidal Type (Airy Waves Type)

Table (2) shows the result of the calculation with a very small wave amplitude where the value of $\frac{\eta_{max}}{H} = 0.503$ was achieved, which means that the wave profile is not really symmetrical, wave crest is still bigger than wave trough, but it is very close with the symmetry, where the value of $\frac{H}{A} = 2$ was achieved, or $H = 2A$. Therefore, it can be determined that as a criteria Airy wave type or sinusoidal wave type is $H = 2A$. The example of sinusoidal wave profile is on Fig.4., where wave crest with wave trough is symmetrical, i.e. $\eta_{max} = |\eta_{min}|$.

Table.2: Wave amplitude for sinusoidal wave, at deep water.

T (sec.)	A (m)	$\frac{\eta_{max}}{H}$	H (m)	$\frac{H}{A}$
8	0,017	0,503	0,035	2
9	0,02	0,503	0,041	2
10	0,023	0,503	0,047	2
11	0,027	0,503	0,053	2
12	0,03	0,503	0,06	2
13	0,033	0,502	0,067	2
14	0,037	0,502	0,073	2
15	0,04	0,502	0,081	2

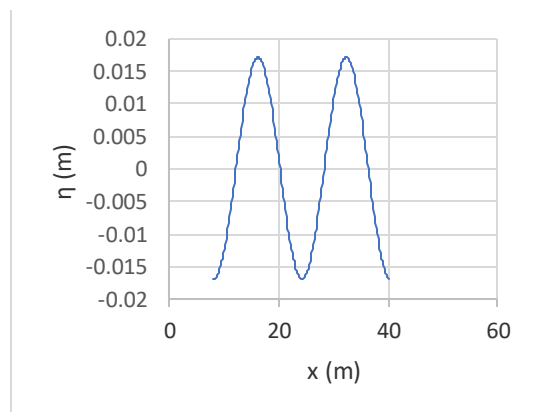


Fig.4. Sinusoidal wave T = 8 sec., A = 0.017 m, at deep water.

Fig.4. is the shape of wave surface sinusoidal for wave period 8 sec., which shows that wave crest and wave trough are symmetrical, i.e., $\eta_{max} = |\eta_{min}|$.

4.4. Cnoidal Type

Table (3) and Table (4) show the result of the calculation of wave profile characteristic with wave amplitude $0.523A_{max}$ and A_{max} .

With wave amplitude of $0.523A_{max}$, $\frac{\eta_{max}}{H} = 0.635$ was obtained, which, according to Wilson criteria is the maximum limit of Stoke's wave type. The value of $\frac{H}{A} = 2.099$, is still quite close with 2.

Table.3: Wave profile at wave amplitude $A = 0.523A_{max}$

T (sec.)	A (m)	$\frac{\eta_{max}}{H}$	H (m)	$\frac{H}{A_{max}}$
7	0,47	0,635	0,986	2,099
8	0,614	0,635	1,288	2,099
9	0,777	0,635	1,631	2,099
10	0,959	0,635	2,013	2,099
11	1,161	0,635	2,436	2,099
12	1,381	0,635	2,899	2,099
13	1,621	0,635	3,402	2,099
14	1,88	0,635	3,946	2,099
15	2,158	0,635	4,529	2,099

With wave amplitude of A_{max} , $\frac{\eta_{max}}{H} = 0.803$ was obtained, with the value of $\frac{H}{A} = 2.726 > 2$ with a deviation of 36.3 % of 2.

Table.4: Wave profile at wave amplitude $A = A_{max}$

T (sec.)	A (m)	$\frac{\eta_{max}}{H}$	H (m)	$\frac{H}{A}$
7	0,899	0,803	2,449	2,726
8	1,174	0,803	3,199	2,726
9	1,485	0,803	4,049	2,726
10	1,834	0,803	4,998	2,726
11	2,219	0,803	6,048	2,726
12	2,641	0,803	7,198	2,726
13	3,099	0,803	8,447	2,726
14	3,594	0,803	9,797	2,726
15	4,126	0,803	11,246	2,726

The profile of wave with wave period 8 sec., wave amplitude $A = 1.174$ m or $A = A_{max}$, can be seen on

Fig.5. The cnoidal profile that was formed is very clear and almost perfect.

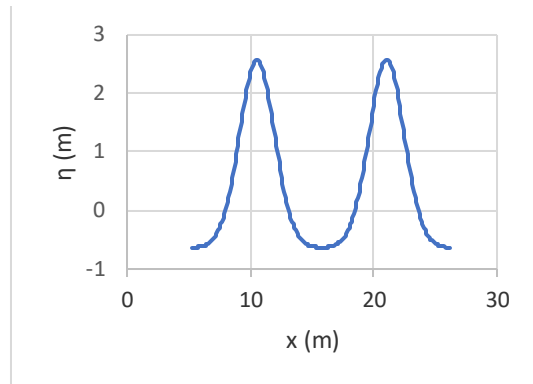


Fig.5. Cnoidal wave $T = 8 \text{ sec.}$, $A = 1.174 \text{ m}$, at deep water.

V. CONCLUSION

In the deep water, there are three types of wave produced by kinematic free surface boundary condition, i.e. Airy waves, Stoke's waves dan cnoidal waves. At a very small wave amplitude, Airy waves type was produced with symmetrical wave profile between wave crest and wave trough and wave height has a value twice of wave amplitude value. By enlarging wave amplitude, Stoke's wave type will be obtained, where the wave height is still close to twice the wave amplitude. Cnoidal wavetype was obtained by enlarging wave amplitude more than the wave amplitude at Stoke's waves, where at cnoidal waves the value of wave height is bigger than twice the wave amplitude.

The second conclusion is a calculation with an assumption that wave height is twice wave amplitude for a large wave amplitude is inaccurate

As has been stated, the research was done at deep water. Therefore, the next research should be on wave profile at shallow water, particularly at breaker point. This is important to interpret the result of shoaling breaker analysis with wave amplitude variable. It is also to examine wave height produced by a model using wave height as its variable by defining wave height that is twice wave amplitude

REFERENCES

- [1] Dean, R.G., Dalrymple, R.A. (1991). Water wave mechanics for engineers and scientists. Advance Series on Ocean Engineering.2. Singapore: World Scientific. ISBN 978-981-02-0420-4. OCLC 22907242.
- [2] Wilson, B.W., (1963). Condition of Existence for Types of Tsunami waves, paper presented at XIII th General Assembly IUGG, Berkeley, California, August 1963 (unpublished).
- [3] Hutahaean, S. (2019a). Application of Weighted Total Acceleration Equation on Wavelength Calculation. International Journal of Advance Engineering Research and Science (IJAERS). Vol-6, Issue-2, Feb-2019. ISSN-2349-6495(P)/2456-1908(O).
<https://dx.doi.org/10.22161/ijaers.6.2.31>
- [4] Hutahaean, S. (2019b). Correlation of Weighting Coefficient at Weighted Total Acceleration With Rayleigh Distribution and with Pierson-Moskowitz Spectrum. International Journal of Advance Engineering Research and Science (IJAERS). Vol-6, Issue-3, Mar-2019. ISSN-2349-6495(P)/2456-1908(O).
<https://dx.doi.org/10.22161/ijaers.6.3.31>

The Use of Smartphones by Brazilian Deaf Students in the Process of Learning Portuguese as a Second Language

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Abstract—Sign languages are usually the mother tongue of deaf people. The official language spoken in a given society is learned as a second language by them. The process of learning this second language is something hard and complex because deaf individuals are not able to hear sounds of any oral languages. Actually, they use such languages only through written messages. This study discusses how the use of smartphones by teen deaf students contributes to the acquisition of Portuguese as a second language, identifying how deaf individuals use smartphones to interact with other deaf and with hearing people through written Portuguese. The research was developed in a qualitative approach with five deaf participants from high school in Brazil. Data were collected through interviews and observations and showed that the use of smartphones has provided multimodal tools that enable the deaf to overcome linguistic and cultural barriers related to the use of Portuguese. Through digital devices they can learn the language with the help of translator apps, images, videos and texts, becoming more proactive and independent in the learning process.

Keywords—Deaf learners, deaf studies, second language learning, sign language, smartphones.

I. INTRODUCTION

Portuguese is the major official language of Brazil and, therefore, the most widely spoken language by a population of more than two hundred million people in that country. However, for a minority group formed by Brazilian deaf people, Portuguese is not easily acquired as a mother tongue. Due to their hearing impairments, these people usually learn Brazilian Sign Language (Libras) as their first language (L1). Since 2002, Brazilian government consider Libras an official language and its use has been encouraged in educational system, teacher training programs and government communications, but it does not have the same prestigious place as Portuguese in everyday communication.

Learning Portuguese is something that demands a long time for deaf people just because they cannot hear spoken languages. In fact, they have usually acquired Portuguese as a second language (L2) after being a fluent user of the sign language. Besides, deaf individuals are not expected to speak Portuguese orally, but they have to learn how to read it and write it.

When deaf do not master Portuguese, they have problems in their academic life as well as in the work environment. Libras is an effective means of communication; but, it can be understood only by those who have mastered it. Sometimes deaf people can count

on Portuguese-Libras interpreters to interact with hearing people who have no idea about the sign language they use, but these interpreters are available just in specific situations. Actually, acquiring Portuguese as a second language empowers the deaf, giving them autonomy to access educational, professional and cultural aspects of the society where they live.

A deaf individual does not learn how to read and write Portuguese the same way hearing individuals do. The deaf need to have access to special pedagogical methodologies based on images rather than sounds. For a long time deaf children were sent to school but did not achieve the same academic skills achieved by hearing children. The problem was not on the deaf who did not learn, but in the way they were taught (Sá, 2011; Salles, Faulstich, Carvalho, and Ramos, 2004). For most of deaf students, Portuguese language seemed to be something unreachable. For them, reading and writing were boring activities related to school with nothing to do with everyday life.

However, since smartphones become more and more popular in Brazil, deaf people have found out that written Portuguese is something useful, actually indispensable, for everyday communication. In fact, the access to internet and the use of apps for interaction in different situations have created a favorable environment for the

deaf to use the major language of the country. For them, not reading or writing this language may implicate in a barrier for social interaction.

This article presents the results of a research which tried to understand how the use of smartphones by teen deaf students contributes to the acquisition of Portuguese as a second language, identifying how deaf individuals use smartphones to interact with other deaf and with hearing people through written Portuguese. The research was developed in Senhor do Bonfim, a small city located in Bahia State, Brazil. Five teen deaf students, from high school, took part in the study as subjects.

II. MATERIALS AND METHODS

This research was developed on a qualitative approach, which considers values, ideas and the worldview of individuals as elements to be analyzed as a whole. Deaf participants were contacted at a government school and invited to take part into the study. They were explained how the research would be developed and agreed to collaborate. In this text they are not identified by their names, instead, we use a code to refer to them through the text: Deaf Student 01, Deaf Student 02, Deaf Student 03, Deaf Student 04, Deaf Student 05. We did not take into consideration any questions related to specific age or gender.

The interviews were carried individually in Libras and Portuguese. A Portuguese-Libras interpreter helped with the interaction between researchers and deaf participants. The interviews were recorded in videos and were transcribed in Portuguese. Some excerpts from the interviews were taken to illustrate the analyses in this work.

III. THE USE OF SMARTPHONES BY DEAF INDIVIDUALS

The use of mobile devices like smartphones by Brazilian people, according to some data from the National Telecommunication Agency (ANATEL), has been increasingly growing, with numbers that surpass the use of personal computers. Although there are no data about the use of such devices by deaf population, it is possible to infer that deaf people in Brazil follow this tendency in the use of that kind of technology.

Information collected among the deaf in this research revealed that all of them use smartphones connected to the internet; what means that the deaf have access to technological devices that enable them to communicate, helping them to overcome some hearing impairments, and giving them autonomy to learn wherever they are. After all, as it has been said by Santaella (2013, p. 137) “with

mobile devices we can move in the physical world and, at the same time, access the space of informational cloud the surrounds us, it can be said that the horizon of ubiquity is opened up for us”.

During the interviews we did, teen deaf students were questioned about the main apps or social network they usually used to communicate through their smartphones. WhatsApp and Facebook were mentioned as the most commonly services used in everyday communication. According to Mobile Messaging Report (available at <https://mobileecosystemforum.com/mobile-messaging-report-2016/>) released in 2016, WhatsApp was the most common app for instant messaging among Brazilians (76% used this app and 64% of them used Facebook). As we could infer, deaf people do not use the mentioned services because of anything special about their deaf identity; in fact, deaf individuals have to deal with the same social and cultural issues and tendencies that are related to society as a whole. It is important to highlight that the combination of the use of smartphones, by the deaf, with instant messaging services and apps, enhances the perspective on inclusion of such individuals in social life, and enables them to understand the complex use of Portuguese language for social communication.

Deaf people tend to use technological resources that are available in their community, as it was noticed by Power, Power and Hortsmanshof (2007). But, such availability depends on economic issues and public policies developed for telecommunication systems in the country where deaf people live as showed by Agboola and Lee (2000). Increasingly, mobile devices have become tools for empowerment and autonomy of deaf people in learning and communication processes (Poçani, 2015). Communication through smartphones has not been limited to sound (like in traditional callings) or text (like in SMS (Short Message Services)). This kind of device has provided what can be called multimodal communication processes, involving sound, text, image, video, etc, enabling deaf people to use sign languages through video call or to use any other languages, like Portuguese, through written texts, with the support of images.

Technological devices have provided new ways of producing, organizing and sharing social and cultural knowledge. Somehow, they have enhanced the use of languages beyond oral and written forms. This is especially important for deaf people, who speak sign languages and are usually challenged to learn the oral language spoken by society. Deaf participants of the research used smartphones to interact even in face-to-face communication, especially when they were talking to someone who was not able to speak in sign language.

They not only use the smartphone to type in Portuguese what they were trying to say, but also illustrated their ideas showing to the interlocutor some images they took from the internet in order to make themselves understandable.

IV. SMARTPHONES AT SCHOOL

School became in western countries an institution suited to industrial society, being traditionally organized like a factory. This can explain why some of its pedagogical patterns are based on order and discipline. Class orientation and teaching methodologies are hardly changed. For this kind of school, books and paper, boards and notebooks are perfect tools to be used in pedagogical programs. In our research, when we asked deaf students about the use of smartphones at school they stated that such devices were prohibited items at the institution they attended. In the interviews we asked the participants: "Do your teachers allow you to use smartphones at school?" These were their answers:

"No, it's forbidden." (Deaf Student 01)

"No, they didn't permit it. They are very strict about this." (Deaf Student 02)

"It is prohibited". (Deaf Student 03)

"No. It's very strict; it's forbidden. We cannot get into school with a cellphone." (Deaf Student 04)

"They are strict when it comes to cellphones, but sometimes they permit the use of them." (Deaf Student 05)

Despite the pedagogical potentialities of smartphones, such devices have not been used for teaching purposes at school. By contrast, these technological apparatus have been present in most of everyday activities. Ribeiro (2016) discusses about this issue, showing through an action-research developed in a Brazilian school that is possible, and very often desirable, to bring smartphones and other mobile devices into classes. These devices may widen the possibilities of communication with the world, interaction between individuals and the access and development of new knowledge. When deaf students are not allowed to use this kind of technology, they have been denied the possibility of surpassing barriers that oral languages impose to them.

Mobile devices, like smartphones, may bring important changes in the way deaf individuals become part of society, helping them to overcoming linguistic and cultural barriers. When the use of such equipment is forbidden at school, some learning processes are limited to traditional teaching patterns that are historically little effective in deaf people education. Information and

communication technologies have been providing the rising of teaching-learning processes which are very different from those ones traditional schools are used to.

Researches all over the world have demonstrated how digital technologies have provided new ways for learning and for social interaction to the deaf (Maiorana-Basas&Pagliaro, 2014; Pilling & Barrett, 2008; Power & Power, 2004). In Brazil, there are some successful experiences about the use of technological devices for deaf education, as it can be showed by Nogueira (2009), Carvalho (2011) and Santos (2015). When the use of smartphones is prohibited at some schools, deaf students have been denied the possibility to access knowledge and new ways of interaction. However, while school methodologies have not been integrated with this technology, deaf individuals have used it out of school borders. Some participants of our research highlighted the importance of the use of smartphones for educational purposes. They stated:

"I use cellphone to study at home" (Deaf Student 03)

"Cellphone helps me when I do some kind of research on the internet" (Deaf Student 04)

It is necessary to mention that it is not only the use of smartphones for academic purposes that contribute for deaf people education. Actually, there are some learning processes that are unintentional; that means, they do not happen only when someone is searching for some pieces of information in order to study about them. The digital world deaf people take contact with, through their smartphones, provides them a context that favors unpredictable situations for learning things one sometimes is not intended to. When individuals are connected to the internet, they can be in contact to other individuals, being part of a multidimensional corpus of information and knowledge. This is the perfect context for a kind of learning some researchers would define as ubiquitous. According to Santaella (2014), this kind of learning is "unpredictable, disperse, fragmented, even chaotic, not always linked to memory. However, undeniably learning" (p.19).

Even if schools do not allow students to use smartphones, they have used them in informal contexts, away from restrictions imposed by educational institutions. Traditional school activities are not effective for deaf individuals to learn. Fernandes (2008) has argued that traditional methodologies used to teach deaf individuals have not been effective since they are based only in written texts and memorization. We have claimed that the digital era we live has brought new possibilities for teaching oral languages to deaf people. Smartphones have the technological frame to develop multimodal

perspectives of interaction and use of languages, both oral and signed. In other words, such devices allow the deaf to be included into society without any special adaptations. After all, everybody has used smartphones and other digital devices for performing innumerable daily activities.

When first communication devices were developed, the deaf were important users, somehow. The telephone, for example, was invented by Alexander Graham Bell at the end of the 19th century as an improvement of devices originally thought for hard of hearing people as we can find in Pilling and Barret work (2008). Nowadays, in a world of digital revolution, the deaf have amplified their communicative and learning skills in a way that has not seen before.

V. PORTUGUESE LANGUAGE AND THE DEAF

According to Ellis (2003), subjective aspects like interest and satisfaction are important elements for a learner who is engaged in the process of acquiring a second language. Considering the subjective approach of our research, we asked deaf participants if they liked to use Portuguese to communicate. Although most of them had answered affirmatively to this question, their statements reveal some caveats about the use of the language. They were asked: Do you like using Portuguese language to communicate?

“So, so. I have a difficult communication with hearing people. When I use Portuguese with deaf individuals, I can understand a little better.” (Deaf Student 01)

“I like it. It is important to learn Portuguese. I think it’s important.” (Deaf Student 02)

“I like it” (Deaf Student 03)

“So, so. But, too long texts, I don’t like.” (Deaf Student 04)

“Yes, I do.” (Deaf Student 05)

Motivation is something one should develop when learning a second language. The fact of liking the language is a positive attitude for the deaf who are learning Portuguese. However, this aspect itself is not conclusive for a deaf learner to be successful when acquiring that L2. Some participants pointed out that although they liked the Portuguese language they have some difficulties about using it, as remarked by Deaf Student 01 and Deaf Student 04.

Salles, et al. (2004) and Pereira (2014) stated that the way a deaf learner write a sentence in Portuguese is very different from the way a hearing individual does. The first usually put words in a sentence not following the exact rules of Portuguese syntax. For the latter, sometimes, a

text written by the deaf may seem a set of chaotic words without any kind of order. Deaf people learn written words as images and the way they organize them in a text tend to follow rules of their L1, Libras, which is a visual language. This is why deaf learners do not follow the linear logic the syntax of an oral language is based on.

For the deaf, the sequence of letters of a word is not learned through the help of sounds of spoken sentences, like most of hearing people do. For them, each word must be understood as a whole image. Unlikely hearing people who learn how to write the language they have been speaking since young age, deaf individuals have to learn a language, for the first time, through its written form. Therefore, the longer a text is, the harder it becomes for a deaf to understand it. In a text, the meaning of a word must be taken considering the context, the whole sentence. For the deaf, this is a real challenge. In the interviews, we asked them if they were able to understand Portuguese language using smartphones. These were their answers:

“Just some words. I understand a little bit of Portuguese, but some words are very long, difficult. Sometimes I showed them to Y. [a hearing relative] and he translates it into Libras.” (Deaf Student 01)

“No, it’s very difficult. I copy phrases and paste them in an app that translates Portuguese-Libras, and then I understand.” (Deaf Student 02)

“Only some words. Some words I don’t understand.” (Deaf Student 03)

“Some words, some sentences. There are words I don’t understand, I don’t know how to say them using signs in Libras. I just put them in a Portuguese-Libras translator app that gives me the sign. (Deaf Student 04)

“So, so” (Deaf Student 05)

Statements from Deaf Students 01, Deaf Student 02, and Deaf Student 04 highlight the necessity deaf learners have to link Portuguese words to equivalent signs in Libras. Ellis (2003) and Krashen (2002) explained that when individuals are learning a second language, they use the linguistic structures of their mother tongue. In our research, deaf participants revealed that they understand Portuguese a little better when they are able to compare the language to Libras. Deaf Student 01 mentions she uses to ask for someone else help in translating written words into Libras. Alternatively, Deaf Student 02 and Deaf Student 04 use technological devices to learn words in Portuguese without the assistance of someone else. Direct interaction, in a person-to-person basis, mentioned by Deaf Student 01 is the oldest strategy one can use to learn a second language: someone who speaks both L1

and L2 teaches one of these languages to individuals who speak just one of them.

On the other hand, Deaf Student 02 and Deaf Student 04 mention technological mediation as a means of learning Portuguese. This is something that must be taken into consideration when we talk about the way deaf people learn a second language. Mobile devices, like smartphones, are part of everyday life. Their digital platform embrace multiples functions, making the access to words, texts, images and apps something practical and fast, what is helpful for someone learning languages. Bellow, we have deaf students' answers to the question: Does the use of smartphones help you in learning Portuguese?

"Yes, a little bit." (Deaf Student 01)

"I think so" (Deaf Student 02)

"It does. Some Portuguese words I ask to Z [a hearing person]. But, some words I check through a smartphone" (Deaf Student 03)

"Veryfewthings. I can't make great progresses" (Deaf Student 04)

"Yes. My mother [a hearing person] teaches me some words. She shows me some signs in Libras, translating them into Portuguese. I learn a little better" (Deaf Student 05)

The statements of Deaf Student 03 and Deaf Student 05 reinforce the claim that the mediation of a bilingual speaker in the process of learning a language by deaf individuals strengthens the possibility of doing it faster. Actually, the more deaf students become familiar to Portuguese, the more they improve their reading and writing skills, becoming more and more independent in the use of technological devices. Deaf participants of our research admit their weaknesses related to their performance as Portuguese users, but emphasize the importance of technological apparatus for everyday communication in both Libras and Portuguese.

When deaf individuals use their smartphones to communicate, they can interact with hearing people who does not understand Libras. Besides written text, these devices provide some digital resources for interaction that involve images (like pictures, emoji) or videos to express feelings and ideas. For the deaf, digital supports turn written language less artificial and much more active. Furthermore, they can write and read to communicate the same way most of people have done nowadays through app services and social networks.

VI CONCLUSION

The use of smartphones by deaf individuals has helped them to learn Portuguese as a second language.

The use of such devices favors the existence of a virtual context in which deaf people socially interact regardless of sensorial characteristics. Thus, deaf individuals can use written Portuguese in real process of communication, quite different from those ones often developed in schools where the process of literacy used to begin. The available technology provides the technical conditions for language learning process to occur.

Data collected through interviews suggest that smartphones have been used by the deaf for interaction with other deaf individuals and with hearing people. The use of this technological equipment provides a wide range of communicational possibilities for the deaf, especially for allowing the use of texts, images and videos on integrated basis through multimodal platforms of digital apps. Because they have contact with sign language and written Portuguese language in real contexts of communication, deaf individuals have access to bilingual processes of interaction in a mobile way, which favors them to learn Portuguese out of school context, free from time and space limitations.

REFERENCES

- [1] Agboola, I. O., & Lee, A. C. (2000). Computer and information technology access for deaf individuals in developed and developing countries. *Journal of Deaf Studies and Deaf Education*, v. 5, n. 3, pp. 286-289.
- [2] Carvalho, D. (2011). *Software em língua portuguesa/Libras com tecnologia de realidade aumentada: ensinando palavras para alunos com surdez*. Doutorado em Educação, Universidade Est. Paulista Júlio de Mesquita Filho, Marília.
- [3] Ellis, R. (2003). *Second language acquisition*. Oxford: Oxford University Press.
- [4] Fernandes, E. (2008). *Surdez e bilinguismo*. Porto Alegre: Mediação.
- [5] Krashen, S. D. (2002). *Second language acquisition and second language learning*. University of Southern California.
- [6] Maiorana-Basas, M., & Pagliaro, C. M. (2014). Technology use among adults who are deaf and hard of hearing: a national survey. *Journal of Deaf Studies and Deaf Education*, v. 19, n. 3, pp. 400-410.
- [7] Nogueira, J.L. F. (2009). *O software HagáQuê: umaproposta para a prática da línguaportuguesaescritada pessoa com surdez*. Mestrado em Educação, Universidade Federal de Alagoas, Maceió.
- [8] Pereira, M. C. C. (2014). O ensino de português como segunda língua para surdos: princípios teóricos e metodológicos. *Educar em Revista*, Curitiba, edição especial, n. 2, pp. 143-157.
- [9] Pilling, D., & Barrett, P. (2008). Text communication preferences of deaf people in the United Kingdom. *Journal of Deaf Studies and Deaf Education*, v. 13, n.1, pp. 92-103.

- [10] Poçani, V. (2015). *As tecnologias de comunicação digital na inclusão do surdo: o caso Whatsapp*. Mestrado em Ciências Humanas, Universidade de Santo Amaro, São Paulo.
- [11] Power, M. R.; Power, D. (2004). Everyone here speaks TXT: Deaf people using SMS in Australia and the rest of the world. *Journal of Deaf Studies and Deaf Education*, v. 9, n. 3, pp.350–360.
- [12] Power, M. R.; Power, D.; Horstmanshof, L. (2007). Deaf people communicating via SMS, TTY, relay service, fax, and computers in Australia. *Journal of Deaf Studies and Deaf Education*, v. 12, n. 1, p. 80-92.
- [13] Power, D. J., Power, M. R., &Rehling, B. (2007). German deaf people using text communication: short message service, TTY, relay services, fax, and e-mail. *American Annals of the Deaf*, v. 152, n. 3, pp. 291-30.
- [14] Ribeiro, J. C. L. (2016). *Uso do celular na escola: suas representações e conexões com o ensino e com a aprendizagem*. Mestrado em Educação, Universidade do Estado da Bahia, Jacobina, Bahia, Brazil.
- [15] Sá, N. R. L. (2011). *Surdos: qual escola?*. Manaus: Editora Valer e Edua.
- [16] Salles, H. M.M.L., Faulstich, E., Carvalho, O. L., & Ramos, A.A.L. (2004). *Ensino de língua portuguesa para surdos: caminhos para a prática pedagógica*. Brasília: MEC/SEESP.
- [17] Santaella, L. A. (2014). A aprendizagem ubíqua na educação aberta. *Revista Tempos e Espaços em Educação*, v. 7, n. 14, set./dez., pp. 15-22.
- [18] Santaella, L. A. (2013). *Comunicação ubíqua: repercussões na cultura e na educação*. São Paulo: Paulus.
- [19] Santos, L. C. M. (2015). *Aprendizado bilíngue de crianças surdas mediada por um software de realidade aumentada*. Doutorado em Educação, Universidade Federal da Bahia, Salvador, 2015.

Temporal-spatial Control of the difference between Precipitation and Evapotranspiration in Paracatu Sub-basins

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Abstract— Water availability control may be relevant regarding the rational use of water resources. Thus, the objective of this work was to use remote sensing techniques as a tool to assist the control of the decennial difference between precipitation and evapotranspiration (S_p) in sub-basins of the Paracatu River. Negative values of S_p were observed in almost the complete study area, therefore, indicating that the region was in the dry season. In terms of water balance, the knowledge of the spatial-temporal of the S_p component can help the planning and control of water resources in watersheds with strong water demand by irrigated agriculture. It is recommended the execution of field validations by installing towers for measurements of the components of the energy balance, as well as the monitoring of the development and growth phases of the crops in association with water balance for each type of use of the land.

Keywords— basin management, land use, Sebal, water resources.

I. INTRODUCTION

Water demand control and availability on a large scale are of paramount importance for the management of water resources in a river basin [1, 2]. Thus, the knowledge of the water availability in both space and time may be essential to assist the rational use of water resources, while alleviating the risks of loss of crop productivity through decision-making directed to an efficient and sustainable water planning. According to Rollenbeck and Anhuf [3], evapotranspiration (ET) is the main link between hydrology and meteorology as it contributes, in a significant way, in the partition of energy balance at the surface and on the regional water balance.

Regarding ET estimation, several methods have been proposed, such as the energy balance based on Bowen's ratio and the method of turbulent correlations. However, these methods are precise and require a large number of field measurements to achieve a sufficiently distributed data density for the spatialization of ET estimates on a regional scale [4]. As a result, the use of remote sensing techniques has become a potential tool for the determination of energy flows and, therefore, of large-scale ET [5, 6, 7, 8, 9], therefore, algorithms and models are used.

Surface Energy Balance for Land (SEBAL) is an algorithm that with the use of few field data, allows the estimation of the energy fluxes that occur at the soil-vegetation-atmosphere interface with not many field data [10, 11]. This algorithm has been developed in a modular way, allowing other models to be used to estimate large scale water balance components, such as the difference between precipitation and ET [1].

Water balance quantifies the water flows; that is, it calculates the inputs and outputs of water in a physical unit, which can be a river basin in a particular time interval. In general, water inflows can occur through precipitation and irrigation, and the outflows by surface runoff and ET. The difference between precipitation and ET is the first component to be determined in a water balance.

Therefore, the objective of this work was to apply the SEBAL algorithm together with MODIS (Moderate Resolution Imaging Spectrometer) data as a tool to assist the control of the decennial difference between precipitation and ET in Paracatu river sub-basins.

II. MATERIAL AND METHODS

The Paracatu river basin is located in the middle of the São Francisco river. It drains an area of approximately 45,600 km², being the second largest sub-basin of the São Francisco river. It is located almost entirely in the state of Minas Gerais (92%), including only 5% of its area in the state of Goiás and 3% in the Federal District [12]. The sub-basins of Entre Ribeiros and Preto rivers, the object of this study, represent about 30% of the area of the Paracatu basin. These two sub-basins, located in Alto Paracatu, cover part of the territories of the Federal District and the States of Minas Gerais and Goiás (Figure 1).

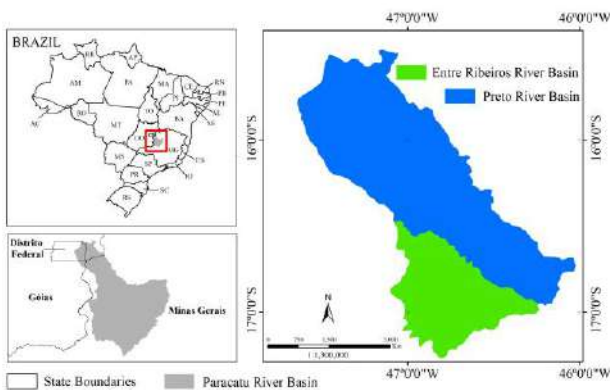


Fig. 1: Location of the study area.

The climate in the region of study is rainy tropical, with rainfall concentrated from October to April; November, December and January stand out as the rainiest months as it can be seen in Figure 2. The annual average precipitation is of 1,338 mm, while the average annual evapotranspiration is 1,140 mm [13]. The primary uses of water resources in the sub-basins of Entre Ribeiros and Preto rivers are to meet the demands of urban, animal, and irrigation supplies. In the Paracatu basin, most of the irrigated areas are concentrated in the headwaters up to half of their drainage system, especially in the Entre Ribeiros stream and the Preto river, which correspond to 53% of the irrigated area identified in the basin by the Director Plan of Water Resources of Paracatu Basin [13].

The products of the MODIS sensor: MOD09GA (surface spectral reflectance, bands 1 to 7), MOD11A1 (surface temperature, bands 31 and 32) and MOD07 (zenith angle) of days 2, 16 and 23 of September 2007 were obtained in the HDF (Hierarchical Data Format) and converted to the GeoTIFF format using the MRT (MODIS Reprojection Tool) software. Apparently, the selected images were cloudless.

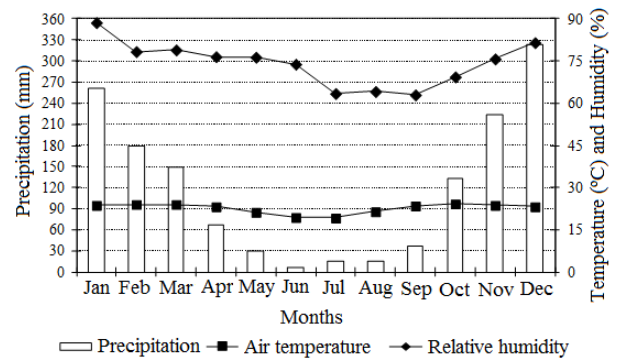


Fig. 2: Monthly average data of rainfall (mm), air temperature (°C), and air relative humidity (%) for the municipality of Paracatu-MG.

Wind speed and incident shortwave radiation data from the automatic meteorological station (A542) located in the Municipality of Unaí, MG, were used. Also, daily rainfall data from 16 stations were used to estimate the difference between precipitation and evapotranspiration (S_p). Figure 3 shows the spatial distribution of the ten rainfall stations from the Brazilian Water Agency (ANA) and the six meteorological stations owned by the Brazilian Institute of Meteorology (INMET), of which two are automatic, and four are conventional.

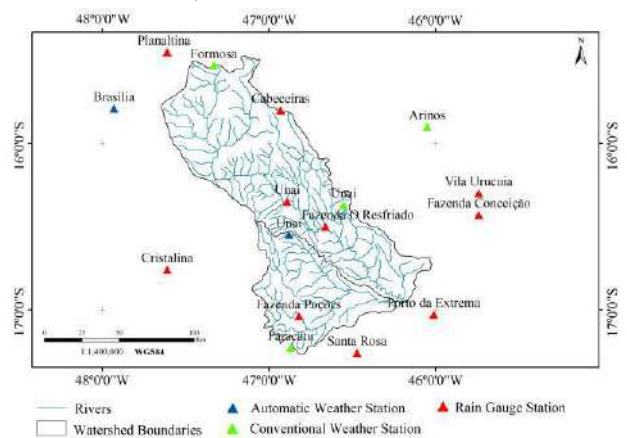


Fig. 3: Location of rainfall stations of the Brazilian Water Agency (ANA) and automatic and conventional meteorological stations of the Brazilian Meteorological Institute (INMET).

In order to obtain the decennial evapotranspiration, the processing steps of the SEBAL algorithm were performed. Thus, the radiation balance (R_n) was the first component of the energy balance to be obtained. For this, the equation suggested by Allen et al. [14] was used:

$$R_n = R_{s\downarrow} - \alpha R_{s\downarrow} + R_{L\downarrow} - R_{L\uparrow} - (1 - \epsilon_o) R_{L\downarrow}$$

Where: $R_{s\downarrow}$ is the incident short-wave radiation ($W m^{-2}$), α is the surface albedo (dimensionless), $R_{L\downarrow}$ is

the long-wave radiation emitted by the atmosphere ($W m^{-2}$), $R_{L\uparrow}$ is the longwave radiation emitted by the surface ($W m^{-2}$), ε_o is the emissivity of the surface (dimensionless).

Then, heat flux in the soil was determined:

$$G = \left[\frac{T_s}{\alpha} (0,0038\alpha + 0,0074\alpha^2)(1 - 0,98 NDVI^4) \right] Rn$$

Where: G is the heat flux in the soil ($W m^{-2}$), T_s is the surface temperature ($^{\circ}C$) relative to the product MOD11A1, NDVI is the vegetation index of the normalized difference (dimensionless).

Then, the sensible heat flux was obtained. It expresses the rate of heat transferred from the surface to the air through the convection and conduction processes.

$$H = \frac{\rho c_p dT}{r_{ah}}$$

Where: H is the sensible heat flux ($W m^{-2}$), ρ is the density of the moist air ($1.15 kg m^{-3}$), c_p is the specific heat of the air at constant pressure ($1004 J kg^{-1} K^{-1}$), r_{ah} is the aerodynamic resistance to the sensible heat flux ($s m^{-1}$), dT is the difference of the air temperature between two levels above the surface, that is, at the height of 2.0 m and 0.1 m.

The latent heat flux (LE) was calculated as the residue of the energy balance equation, through the simple difference between the balance of radiation and soil and sensible heat fluxes.

$$LE = Rn - G - H$$

By using the energy balance components, it was possible to calculate the evaporative fraction (λ) using the expression suggested by Bastiaanssen et al. [11]:

$$\lambda = \frac{LE}{LE + H} = \frac{LE}{Rn - G}$$

The evaporative fraction was used to estimate the decennial evapotranspiration through the equation:

$$ET_{dec} = n \lambda \overline{Rn}_{24h}$$

Where: ET_{dec} is decennial evapotranspiration ($mm dec^{-1}$), n is the number of days in the considered ten-day period, \overline{Rn}_{24h} is the average radiation balance in each ten-day period ($W m^{-2}d^{-1}$).

The daily precipitation data for each station were accumulated in ten-day periods, which were defined as follows: D1 = days 1 to 10; D2 = days 11 to 20 and D3 = days 21 to 30. After that, data interpolation was carried out, and the spatialization of decennial

precipitation was performed. Next, the decennial difference between precipitation (P_{dec}) and evapotranspiration (ET_{dec}), named S_p was estimated:

$$S_p = P_{dec} - ET_{dec}$$

III. RESULTS AND DISCUSSION

Figure 4 shows the LE maps for the sub-basins of Entre Riberios and Preto river. However, it can be seen in Table 1 the statistical data for LE, ET_{dec} , and S_p . According to the maps of Figure 4, it is possible to notice a high variability in LE. The values of LE between 0 and $200 W m^{-2}$ (yellow and orange shade) predominated in most of the sub-basins in the estimates for the first ten days of September (Figure 4A), while for the second (Figure 4B) and the third (Figure 4C) ten-day periods, values between 200.1 and $400 W m^{-2}$ (green and light blue shade) predominated. Besides, in some of the region on the Vereda Grande creek and the Entre Riberios and São Pedro streams, LE values between 400.1 and $500 W m^{-2}$ (dark blue) were observed. These higher values are justified both by the presence of water bodies and by the area of riparian forest, as shown by the area highlighted in Figure 4C. In a study carried out in the city of Patos, state of Paraíba, Gomes et al. [15] found values of LE ranging from 4.71 to $598 W m^{-2}$, with the highest values observed on water bodies. Besides, the authors point out that LE reached the value of $420 W m^{-2}$ in areas covered by vegetation and in the sub-basin of the Espinharias river.

The negative values (black shade) were observed for the three ten-day periods of LE estimation, mainly in areas of the Upper Preto river in estimates for the first and third ten-day (Figures 4A and 4C, northern portion highlighted in a dotted rectangle on the map). Arya [16] points out that the values of H, LE, and G are generally positive during the day. In exceptional circumstances, such as irrigated fields, H and, or, G assume negative values, whereas LE, due to evaporative surface cooling, may exceed the surface radiation balance. According to this author, the magnitudes of energy balance components depend on many factors, such as surface type and its characteristics (soil moisture, texture, vegetation, etc.), geographic location, season, time of day and climate. Another justification for obtaining negative values may be possible cloud contamination of the pixel, which disguises the expected results for a specific region.

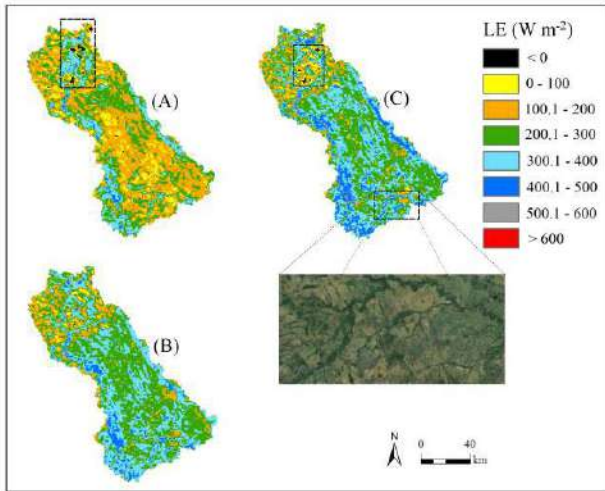


Fig. 4: Latent heat flux maps ($LE, W m^{-2}$) for September 2 (A), September 16 (B) and September 23 (C) 2007. A prominent view of part of the stream Vereda Grande and Entre Rios and São Pedro (C).

In the study by Nicácio [17], negative values of LE were found in most of the area occupied by open native vegetation, exposed soil areas, and urbanized regions. This author points out that a possible reason for this behavior may be attributable to the occurrence of lower values of the balance of radiation associated to the increase of the amount of energy destined to the heating process of the air and the soil. Another justification may be related to the type of land use and cover, in this case, Andrade et al. [6] observed that this factor influenced the values obtained for the components of the energy balance. For example, if the area represented by a MODIS pixel has considerable heterogeneity of use and coverage, then the resulting value of LE will be influenced by the degree of intensity of this heterogeneity. Aguiar et al. [18] state that because of the spatial resolution of MODIS, a scene element, corresponding to a pixel of the image, may include more than one type of land cover and the detected radiance will be represented by the integration, called blending, of all objects contained in the scene element.

Table 1 shows that average LE varied between 202.98 ± 87.28 and $292.39 \pm 90.19 W m^{-2}$. The minimum and maximum values, -158.59 and $696.72 W m^{-2}$, respectively, occurred on September 2, 2007. These results were within the range of maximum values found by Mendonça [19] who estimated values between 417.44 and $829.71 W m^{-2}$ by using the proposition "Classical." The maximum values of LE also corroborate with the results found in studies conducted in the Brazilian Northeast by Bezerra et al. [20, 21].

Table 1: Minimum, average and maximum values and standard deviation (SD) of latent heat flux ($LE, W m^{-2}$), decennial evapotranspiration (ET_{dec}, mm) and decennial perception between rainfall and evapotranspiration (S_p, mm) observed for the sub-basin of Entre Ribeiros stream and Preto river

Date	LE ($W m^{-2}$)			ET _{dec} (mm)			S _p (mm)		
	02/09	16/09	23/09	D1	D2	D3	D1	D2	D3
Min.	158.59	38.35	73.41	0.00	0.00	0.00	59.16	61.99	61.32
Max.	696.72	639.92	653.78	59.16	61.99	61.32	0.00	0.00	0.56
Average	202.98	279.75	292.39	20.89	30.30	30.30	21.12	30.41	29.02
SD	87.28	78.03	90.19	8.36	7.42	8.31	8.36	7.42	8.31

Figure 5 shows the thematic maps of the ET_{dec} for the sub-basins of the Entre Ribeiros stream and Preto river. Average ET_{dec} varied between 20.89 ± 8.36 and $30.30 \pm 8.32 mm$, with minimum and maximum values of 0.00 and $61.99 mm$, respectively (Table 1). For the three ten-day periods of September 2007, the high variability of ET_{dec} was evident, and this was probably due to the heterogeneity of areas (Cerrado, pasture, urban area, watercourses, irrigated areas with different types of crops, etc.).

Figure 5A shows that ET_{dec} between 10.1 to $20.0 mm$ (orange shade) predominated particularly in the Middle and Lower Preto Rivers. Also, the classes of ET_{dec} values within the ranges of 20.1 to $30 mm$ (green shade) and 30.1 and $40.0 mm$ (light blue shade) are highlighted. However, in the second and third ten-day period of September (Figures 5B and 5C) an increase in ET_{dec} was observed, where values ranging from 20.1 to $40.0 mm$ (green and light blue shade) predominated. In general, ET_{dec} was greater than $40 mm$ in areas over watercourses. In some cases, such as, for example, part of the Preto river that borders the States of Goiás and Minas Gerais (highlighted in the Figures 5B and 5C), values greater than $50.1 mm$ (gray shade) were observed.

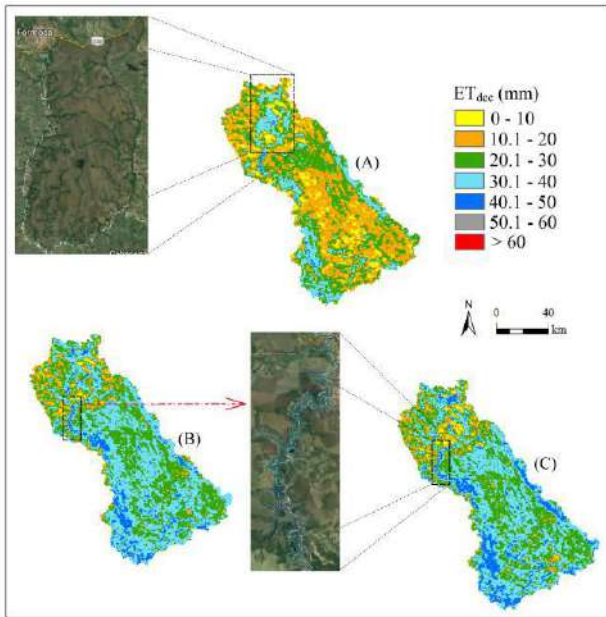


Fig. 5: Evapotranspiration maps (ET_{dec} , mm) for the first ten-day period (A), second ten-day period (B) and third ten-day period (C) of September 2007. Estimates made for the sub-basin area between Entre Ribeiros and Preto river. Cerrado (A) and part of the Preto river (B and C) are highlighted.

Figure 6 shows the thematic maps of S_p for the three ten-day periods of September 2007. It is noted that $S_p > -30$ mm were spatially more extensive in the first ten-day (Figure 6A). However, the inverse was observed for the second (Figure 6B) and the third (Figure 6C) ten-day period for September 2007.

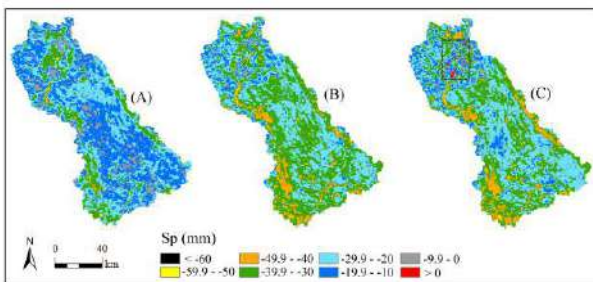


Fig. 6: Precipitation and evapotranspiration difference (S_p , mm) maps for the first ten-day period (A), second ten-day period (B) and third ten-day period (C) of September 2007. Estimates made for the sub-basins area of Entre Ribeiros stream and Preto River.

The occurrence of negative values in most sub-basin areas, except for small areas of red (> 0 mm) in the dotted rectangle of the northern portion of the basin (Figure 6C), indicates that the precipitation in the three ten-day periods was insufficient. This is because S_p will be positive when P_{dec} overcomes ET_{dec} . The average precipitation data of

the conventional station of Paracatu, state of Minas Gerais (Figure 2) shows that September is a month characterized by the transition between dry and rainy season.

In the third ten-day in September, only the stations of Porto da Extrema (6.4 mm) and Unaí (11.0 mm) recorded rainfall volumes. These rains occurring until the second ten-day in October are essential in the restoration of the natural moisture of the soil and the supply of water demand by the vegetation. Meanwhile, later rains can contribute more significantly both to supply the water demand of vegetation and to recharge the aquifers on a regional scale. The total ten-days for October showed an increase in the occurrence of rainfall, and in the third ten-day, the rainy season may have started in the region. Minuzzi et al. [22] ratify this information, stressing that the rainy season in the sub-basin region, usually starts between October 13 and 22.

By using as an example the total precipitation recorded at the Paracatu station, in the state of Minas Gerais from September and October, it can be stated that the rains were below the historical average. In this case, the expected historical average for September and October is 35.9 and 132.8 mm, respectively. Thus, rainfall volumes below the historical average may justify the predominance of negative values of S_p in the three analyzed ten-day periods.

IV. CONCLUSIONS

For the three ten-day periods of September 2007, S_p was negative in almost the entire area of the sub-basins of the Entre Ribeiros stream and Preto river, therefore, indicating that the region was in the dry season, with rainfall records below the historical average for the period.

Overall, the use of MODIS sensor products to estimate S_p was relevant due to its extensive spatial coverage as well as the possibility of generating time series that help the understanding of surface biophysical processes in a river basin scale.

Estimates of S_p become an important variable in terms of water balance, being promising to assist in the planning and controlling of water basins with strong water demand by irrigated agriculture. However, regarding complementary studies, it is recommended that field validations are performed with the installation of towers for measurements of energy balance components as well as the monitoring of development and growth phases of crops in association with water balance for each type of land use.

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REFERENCES

- [1] Bastiaanssen, W. G. M.; Chandrapala, L. (2003). Water balance variability across Sri Lanka for assessing agricultural and environmental water use. *Agricultural Water Management*, 58, pp. 171-192.
- [2] Morrow, E.; Mitrovica, J. X.; Fotopoulos, G. (2011). Water storage, net precipitation, and evapotranspiration in the Machenzie River Basin from October 2002 to September 2009 inferred from GRACE satellite gravity data. *Journal of Hydrometeorology*, 12, pp. 467-473.
- [3] Rollenbeck, R.; Anhof, D. (2007). Characteristics of the water and energy balance in an Amazonian lowland rainforest in Venezuela and the impact of the ENSO-cycle. *Journal of Hydrology*, 337, pp. 377-390.
- [4] Compaoré, H.; Hendrickx, J. M.; Hong, S.; Friesen, J.; Giesen, N. C. van de; Rodrigues, C.; Szarzynski, J.; Vlek, P. L. G. (2008). Evaporation mapping at two scales using optical imagery in the White Volta Basin, Upper East Ghana. *Physics and Chemistry of the Earth*, 33, pp. 127-140.
- [5] Tasumi, M.; Allen, R. G.; Trezza, R. (2008). At-surface reflectance and albedo from satellite for operational calculation of land surface energy balance. *Journal of Hydrologic Engineering*, 13, pp. 51-63.
- [6] Andrade, R. G.; Sedyama, G. C.; Paz, A. R.; Lima, E. P.; Facco, A. G. (2012). Geotecnologias aplicadas à avaliação de parâmetros biofísicos do Pantanal. *Pesquisa Agropecuária Brasileira*, 47, pp. 1227-1234.
- [7] Lima, E. P.; Sedyama, G. C.; Andrade, R. G.; Lopes, V. D.; Silva, B. B. (2014). Evapotranspiração real diária em sub-bacias do Paracatu, utilizando produtos do sensor Modis. *Revista Ceres*, 61, pp. 017-027.
- [8] Bezerra, B. G.; Silva, B. B.; Santos, C. A. C.; Bezerra, J. R. C. (2015). Actual evapotranspiration estimation using remote sensing: Comparison of SEBAL and SSEB approaches. *Advances in Remote Sensing*, 4, pp. 234-247.
- [9] Araújo, A. L.; Silva, M. T.; Silva, B. B.; Santos, C. A. C.; Amorim, M. R. B. (2017). Modelagem simplificada para estimativa do balanço de energia à superfície em escala regional (R-SSEB). *Revista Brasileira de Meteorologia*, v.32, pp. 433-446.
- [10] Bastiaanssen, W. G. M.; Menenti, M.; Feddes, R. A.; Holtslag, A. A. M. (1998a). A remote sensing surface energy balance algorithm for land (SEBAL): 1. Formulation. *Journal of Hydrology*, 212-213, pp. 198-212.
- [11] Bastiaanssen, W. G. M.; Pelgrum, H.; Wang, J.; Ma, Y.; Moreno, J. F.; Roerink, G. J.; Van Der Wal, T. (1998b). A remote sensing surface energy balance algorithm for land (SEBAL) 2. Validation. *Journal of Hydrology*, 212-213, pp. 213-229.
- [12] Dino, K. J. (2003). Cultura política local como dimensão da sustentabilidade na gestão de recursos hídricos: o caso do comitê da sub-bacia hidrográfica mineira do rio Paracatu. Brasília, DF: UNB. 135p. Dissertação (Mestrado) – Universidade de Brasília.
- [13] BRASIL. (1996). Ministério do Meio Ambiente. Plano Diretor de Recursos Hídricos da Bacia do Rio Paracatu. Brasília: PLANPAR, v.1, t.1. CD-ROM.
- [14] Allen, R. G.; Trezza, R.; Tasumi, M.; Waters, R.; Bastiaanssen, W. G. M. (2002). SEBAL – Surface Energy Balance Algorithms for Land. Advanced training and user's manual, version 1.0. Kimberly, Idaho: University of Idaho. 98p.
- [15] Gomes, L. C. F.; Santos, C. A. C.; Almeida, H. A. (2013). Balanço de energia à superfície para a cidade de Patos-PB usando técnicas de sensoriamento remoto. *Revista Brasileira de Geografia Física*, 06, pp. 015-028.
- [16] Arya, S. P. (2001). Introduction to micrometeorology. 2.ed., San Diego: Academic Press. 420p.
- [17] Nicácio, R. M. (2008). Evapotranspiração real e umidade do solo usando dados de sensores orbitais e a metodologia SEBAL na bacia do rio São Francisco. Rio de Janeiro, RJ: UFRJ. 320p. Tese (Doutorado) – Universidade Federal do Rio de Janeiro.
- [18] Aguiar, A. P. D.; Shimabukuro, Y. E.; Mascarenhas, N. D. A. (1999). Use of synthetic bands derived from mixing models in the multispectral classification of remote sensing images. *International Journal of Remote Sensing*, 20, pp. 647-657.
- [19] Mendonça, J. C. (2007). Estimativa da evapotranspiração regional utilizando imagens digitais orbitais na região Norte Fluminense, RJ. Campos dos Goytacazes, RJ: UENF. 145p. Tese (Doutorado) – Universidade Estadual do Norte Fluminense Darcy Ribeiro.
- [20] Bezerra, B. G.; Silva, B. B.; Ferreira, N. J. (2008). Estimativa da evapotranspiração real diária utilizando-se imagens digitais TM - Landsat 5. *Revista Brasileira de Meteorologia*, 23, pp. 305-317.
- [21] Bezerra, B. G.; Santos, C. A. C.; Silva, B. B.; Perez-Marin, A. M.; Bezerra, M. V. C.; Bezerra, J. R. C.; Rao, T. V. R. (2013). Estimation of soil moisture in the root-zone from remote sensing data. *Revista Brasileira de Ciência do Solo*, 37, pp. 596-603.
- [22] Minuzzi, R. B.; Sedyama, G. C.; Barbosa, E. da M.; Melo Júnior, J. C. F. de. (2007). Climatologia do comportamento do período chuvoso da região sudeste do Brasil. *Revista Brasileira de Meteorologia*, 22, pp. 338-344.

Relationship between the Learning of Computational thinking and the Development of Reasoning

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Abstract— This work describes a quasi-experimental study which aims to investigate the relationship between the construction of Computational Thinking and the reasoning development of students of the last years of Elementary School. The research was carried out using a 10-hour course in Games Development, offered in two private schools with 50 participant students, in two consecutive years, with four different classes. The proposed teaching-learning practice was built on theoretical assumptions of meaningful learning and experiential learning. Computational Thinking and students' reasoning were evaluated before and after the course, using the Computational Thinking Test and the tests that compose the BPR-5 Testing Battery. The statistical analysis of the data showed an increase in Computational Thinking, as well as in Verbal Reasoning, Abstract Reasoning and Mechanical Reasoning of the students who took part in the experiment. A positive correlation between Computational Thinking and the five types of reasoning evaluated was also documented.

Keywords— Computational Thinking, Intelligence, Cognitive Assessment.

I. INTRODUCTION

It can be said that many young people have vast experience and familiarity in interacting with new technologies, but at the same time have little experience in creating and expressing themselves with new technologies. An extended view of digital fluency assumes that students go beyond the simple domains of Information and Communication Technologies (ICT), requiring an understanding of how computers work and learning to formulate problems and expressing their solution so that either a computer or human beings can carry out.

This way of thinking of Computer Science itself was named Computational Thinking, a term that became popular from the article entitled "Computational Thinking" published in 2006 by Jeannette M. Wing. It should be noted that some of Wing's ideas were already present in Papert's experiments on the LOGO programming language, as well as the idea that the skills developed when learning to program would be transposed into other spheres of life. (PAPERT, 1980)

Although not scientifically proven, it is assumed that the problem-solving process used in Computer Science can be generalized and transferred to a wide variety of

problems in everyday life. Thus, the Computational Thinking would not be a skill related exclusively to the Computer Science graduation course.

It is relevant to elucidate the effects of Computational Thinking learning under cognition. If the influence in the development of reasoning is identified, the importance of this discipline in basic education will surpass a mere market demand.

In scientific literature, there are few studies that evaluate Computational Thinking with objective instruments, and there is practically no research on the impacts of this learning in cognition. Therefore, the main objective of this work is to investigate the relationship between the construction of Computational Thinking and the development of reasoning. The present article was organized in this article is composed of seven sections that follow this Introduction, Computational Thinking, Differential Intelligence Paradigms, Meaningful Learning And Experiential Learning, Methodology, Results and Discussion, Conclusion and References.

II. COMPUTATIONAL THINKING

In the book "Mindstorms: children, computers, and powerful ideas", researcher Papert (1980) discusses the

impact of computers on people's lives and how their use influences the way people think. He noted that children, when learning to program with LOGO, use computer models to organize thinking as they "program the computer to make more complex decisions and find themselves engaged in reflecting on more complex aspects of their own thinking" (PAPERT, 1980, p. 28).

In several sections of the work, Papert presents themes related to what is now called Computational Thinking (CT), however there is no concern from the author in defining this concept. It should be noted that the term "Computational Thinking" is mentioned only once, referring to the insertion of the computer in society and the difficulty of creating an engaging experience with the technologies used in programming clubs. Still, in the work of Papert (1980), Computational Thinking is understood as a way to structure thinking. The author relates CT to logical reasoning, problem solving and debugging. "Learning to be a master of programming is learning to become highly skilled at isolating and correcting bugs" (PAPERT, 1980, p. 23).

The concept of Computational Thinking was popularized through an article by Wing (2006), in which the author states that "Computational Thinking involves solving problems, designing systems and understanding human behavior, by drawing on the concepts fundamental to Computer Science" (WING, 2006, p. 33).

In Computational Thinking: What and Why? Wing (2010, p. 1) describes the mental activity in solving a problem that admits a computational solution and defines Computational Thinking as the "thought processes involved in formulating problems and their solutions, so that solutions are represented in a form that can be effectively carried out by an information-processing agent".

Google for Education describes Computational Thinking as a process that includes four computational thinking techniques: decomposition, pattern recognition, generalization and abstraction, and algorithm design. In this sense, Computational Thinking is understood as:

a set of skills and problem-solving techniques used by software engineers to create programs for the applications you use, such as search, email, and maps. Computational thinking includes the skills and ways of thinking that are used when writing computer programs, but go beyond the use of computers (GOOGLE, 2015).

Royal Society (2012, p. 29) states that "Computational Thinking is the process of recognizing aspects of computation in the world that surrounds us and applying

tools and techniques from Computer Science to understand and reason about both natural and artificial systems and processes".

Publications and researches led by Code.Org (CODE.ORG, 2015), Liukas (2015) and BBC Learning (2015) merged the elements cited by Grover and Pea (2013) summarizing the so-called "Four Pillars of Computational Thinking" (or dimensions) for a problem solving approach: Decomposition, Pattern Recognition, Abstraction, and Algorithms:

- Decomposition – breaking down a complex problem or system into smaller, more manageable parts;
- Pattern Recognition – looking for similarities among and within problems;
- Abstraction – focusing on important information only, ignoring irrelevant details;
- Algorithms – developing a step-by-step solution to the problem, or the rules to follow to solve the problem.

Considering the different definitions for Computational Thinking presented in this paper, it is understood that there is no consensus, for they are associated with the grouping, under the same term, of different impacts of computer usage in our society. Computational Thinking covers processes of three distinct categories: Cognitive Processes, Behavioral Processes, and Social Processes.

- Cognitive processes: related to the impact of computer usage in human cognition. They involve abstraction, logical reasoning, decomposition, algorithm, error debugging, and pattern recognition.
- Behavioral Processes: involve the demands and modifications of behaviors and attitudes: collaboration, perseverance, and sharing experiences.
- Social Processes: refer to the impacts of the computer on society, such as: automation, simulation, the use of social networks, changes in work organization and its influence in other branches of knowledge.

Therefore, Computational Thinking may be considered a set of transformations noted in the way of thinking, acting, and behaving socially due to the use of computers. With this proposal of categorization, it becomes easier to delimit the field of study of new researches which deal with Computational Thinking. The scope of this research, for example, is limited to analyzing Computational Thinking with regards to the cognitive processes involved.

III. DIFFERENTIAL INTELLIGENCE PARADIGMS

Primi (2003) states that psychology has been seeking for decades to answer the question about the nature of intelligence, which is the central theme of many researches. To ease the understanding of theories about human intelligence, Afonso (2007) suggests classifying the different theories into four paradigms:

- Biological paradigm: refers to the understanding of intelligence as a phenomenon resulting from biological factors, from neuronal level – anatomy, physiology, and functioning of the nervous system, to the most elementary levels, both genetic and biochemical, or more macroscopic, developmental and evolutionary.
- Constructivist or Psychogenetic Paradigm: considers intelligence as a way of adapting to the environment, in which knowledge is constructed by the individual, through the two complementary processes of assimilation and accommodation.
- Informational Paradigm: takes the computerized processing of data as a metaphor and seeks to understand the intelligence in terms of mental processes of information handling.
- Differential Paradigm: emerges from the indication of individual differences in cognitive functioning, as noted through evidence and use of psychological tools.

The present study, proposed to measure the effects of the teaching of Computational Thinking on aspects of intelligence, will be grounded on the Differential Intelligence Paradigm.

According to Primi (2003), the psychometric approach uses a concept of intelligence based on factorial analysis, which is based on the individual differences revealed through hundreds of tests designed to assess cognitive abilities.

For Almeida (2000), the BPR-5 – Battery of Reasoning Tests is the most complete test available in Brazil. This test is based on the most recent factorial conceptions of intelligence, allowing the evaluation of general intelligence: Spearman's¹ G-Factor, as well as more specific intelligence factors. Due to these characteristics this was the instrument used to evaluate the reasoning in this work.

The 5 subtests that make up the BPR-5: AR – Abstract Reasoning, VR – Verbal Reasoning, NR – Numerical Reasoning, SR – Spatial Reasoning, and MR – Mechanical Reasoning, relate to specific intelligence factors:

- The AR subtest is mainly associated with fluid intelligence (Gf) defined as the ability to reason in new situations, to create concepts and to understand implications.
- The VR subtest is associated with fluid and crystallized intelligence (Gc), defined as the extent and depth of vocabulary verbal knowledge, and the ability to reason using previously learned concepts.
- The NR subtest is associated with fluid intelligence and partly with the quantitative skill (Gq) defined as the understanding of basic quantitative concepts such as addition, subtraction, multiplication, division, and manipulation of numerical symbols.
- The ER subtest is partly associated with fluid intelligence, but mainly with visual processing capacity (Gv) defined as the ability to represent and manipulate mental images.
- The MR subtest is partly associated with fluid intelligence, and practical mechanical knowledge.

Almeida (2000) emphasizes that all subtests are associated, to a greater or lesser extent, with fluid intelligence, an ability that is more similar to Spearman's G-factor.

IV. MEANINGFUL LEARNING AND EXPERIENTIAL LEARNING

For Ausubel, Novak & Hanesia (1980), "the most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly". The emphasis of this theory lies in the organization of knowledge in structures and in the restructurings that occur in the subject with the acquisition of new information.

Meaningful learning takes place when new information relates to some relevant aspect of the individual's knowledge structure; new ideas can be learned to the extent that relevant and inclusive concepts are clear and available in the individual's cognitive structure, also called concept anchoring.

According to Ausubel's theory (1980), learning can occur through reception, process by which knowledge is presented in its final form to the learner or through discovery. It is important to point out that "both receptive

¹ Spearman (1904, 1927) found in his experiments that the test scores of different intellectual activities had a correlation between the remaining ones that were still constant. For the author, all branches of intellectual activity would have a common fundamental function, which he named as General Factor, or G Factor.

and discovery learning can be developed in a meaningful or mechanical, depending on the conditions under which the learning occurs” (AUSUBEL et al, 1980, p. 23).

Learning is meaningful if the content is linked to relevant concepts and subsumptions existing in the cognitive structure, therefore the concept of advance organizers is of particular importance. The advance organizers are a knowledge that has the function of facilitating learning on a domain that may be completely unknown, working as a causeway between what the learner already knows and what he should know, these organizers function as a cognitive bridge.

For Ausubel (1980), true advance organizers are those intended to facilitate the meaningful learning of specific topics or closely related ideas. In the meantime, the introductory materials used to facilitate the learning of various topics would be called pseudo advance-organizers.

As a practical example we can mention the teaching code for the movement of sprites in Scratch². In order to learn to move the characters, it is necessary to know the Cartesian plane, as well as the screen resolution used in Scratch (subsumptions).

The Experiential Learning theory highlights the central role that experience plays in the learning process, the process in which knowledge is created through the transformation of experience Kolb (1984). Another reason why the theory is called “experiential” refers to its intellectual origins in the experimental works of Lewin, Piaget, Dewey, Freire and James, constituting a unique perspective on learning and development.

For Kolb (1984), knowledge is created by the transformation of experience, resulting from the combination of understanding and transformation of experience,

mere perception of experience itself is not enough for learning; something must be done with it. Likewise, transformation alone cannot represent learning, for there must be something to be transformed, some state or experience that is being put into practice. (KOLB, 1984, p.42).

Following Dewey, Kolb’s Theory of Experiential Learning (1984) describes how experience is transformed into learning through a cycle involving experiencing, reflecting, thinking, and acting.

The model proposed by the Experiential Learning Theory portrays two opposing ways of consolidating

experience: Concrete Experience (CE) and Abstract Conceptualization (AC), as well as two opposite ways of transforming it: Reflective Observation (RO) and Active Experimentation (AE).

Learning from experience is a process of building knowledge that involves a creative tension between these four ways of learning. This process is portrayed as an idealized or spiral learning cycle in which the student goes through the four fases:

- Concrete Experience: related to personal experiences and feelings involved in the learning situation;
- Reflective Observation: implies on problem solving by reviewing and reflecting on the experience;
- Abstract Concept: the understanding is based on the intellectual understanding of a situation, that is, on the conclusions constructed based on the experience, in which the level of abstraction quite high;
- Active Experimentation: involves active learning in which students plan new experiences, modify variables and influence situations, experience what they have learned and formulate hypothesis.

For this author, learning will be effective when the student makes progress through an environment made up of stages of concrete experience, reflective observation, conceptualization and practical activity.

Kolb and Fry (1975) argue that the learning cycle can begin at any of the four points, and that these steps should be approached as a continuous spiral. However, they suggest that teaching material should be planned to respect the entire learning process, taking into account the sequence of the experiential learning cycle, in order to offer each learner the opportunity to develop skills at each stage of the experiential learning cycle. The Games Development course used in this research, when searching for subsumptions to support the new knowledge, started learning from the Concrete Experience.

V. METHODOLOGY

The experiment was carried out through an course in Games Development, with duration of 10 hours, offered as an extra class activity in the inverse shift of classes for students enrolled in grades 6 to 9 of Elementary School in two private schools in the city of Porto Alegre, in the State of Rio Grande do Sul, Brazil. To verify the effect of the proposed pedagogical intervention, two evaluations of the 50 participant students were carried out. The first

² <https://scratch.mit.edu/>

evaluation was done before the course and the second after the end of the course.

The nature of this study did not allow the random selection of the sample and the control group was not used, because it is a course offered extra class, for this reason, this research is characterized as a quasi-experimental study. However, as the experiment occurred in 7 weeks, this interval reduced the possibility of school learning being responsible for the observed increase.

In the quasi experiment, since no random distribution of units is made under conditions, other principles are used to show that alternative explanations are not plausible. To verify the effect of the proposed pedagogical intervention, two evaluations of the 50 students who participated in the experiment were carried out. The first one before the Games Development Course and the second after the pedagogical intervention, later the average of the groups was compared based on statistical tests.

In order to ensure that the results achieved were related to the research and not to external variables, the Games Development course was offered in four editions. The data collected in this study had the objective of testing two hypothesis which were formulated at the beginning:

- The teaching of Computational Thinking improves students' reasoning ability;
- There is a correlation between Computational Thinking and reasoning ability.

For this purpose, it was foreseen in the research design to analyze the relation of the score achieved in the Computational Thinking Test and the BPR-5 tests, as shown in Fig. 1.

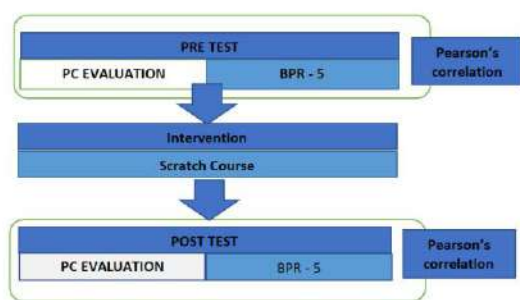


Fig. 1: analysis of the relationship between variables

The first two classes of this experiment happened between October and November 2016 and the others between April and May 2017. The experiment lasted 7 weeks, with weekly meetings with the participant students. The first and the last week were dedicated to evaluation with BPR-5, five weeks were used to carry out the Games Development course.

All of the lessons of the course proposed by this project were planned to start seeking to rescue past experiences of the students, to find subsumptions and to generate discussions about experiences outside the computational context. Next, the students interacted with code snippets. At the later time they were asked about the operation of the code and tested modifications in the programming. Finally, each lesson ended with challenges on the topic covered in Scratch.

VI. RESULTS AND DISCUSSION

6.1 Evaluation of Computational Thinking and Validation of the Teaching Methodology

To meet the specific goal of evaluating students' Computational Thinking, we used the Computational Thinking Test prior to the start of the Games Development course (pre test) and after the course (post test). The test used to evaluate the students was developed by (Román-González, 2015, 2016; Román-González, Pérez-González, et al., 2017), it is a multiple choice test in which there are 28 items with four answer options (only one correct), with a maximum time of 45 minutes to complete the task. This test is intended for children of school age between 12 and 13 years old and aims to measure the level of their Computational Thinking development.

Table 1: Student's mean

School/Class	Students	Pre test	Post test	Difference
School A – 2016	16	17,43	19,69	2,26
School B – 2016	11	14,82	16,09	2,03
School A – 2017	16	14,06	16,69	2,63
School B – 2017	7	15,14	17,29	2,15
Total	50	15,46	17,60	2,14

Font: authors

Considering the difference between means, it can be stated that in all classes of the Games Development Course, there was an increase in students' Computational Thinking. However, further testing is required to determine its statistical relevance.

The normality of the sample made the use of parametric tests possible. The paired T-test was performed, resulting in a one-tailed P ($T \leq t$) of 0.000025. Thus, it has been proven that there is evidence of a 5% increase in the average score of the Computational Thinking Test after students attend Games

Development classes. Considering the Confidence Interval, the averages increased between 1.17 and 3.11 points. The results can be seen in Table 2.

Table 2: Paired t-test

	Pre test	Post test
Mean	15,46	17,6
Difference	24,29429	17,46939
Observations	50	50
Mean difference	2,14	
Pearson correlation	0,732276	
Hypothesis of the mean difference	0	
gl	49	
T statistic	-4,44442	
P(T<=t) one-tailed	0,000025	
One-tailed t critical value	1,676551	
P(T<=t) two-tailed	0,000050	
Two-tailed t critical value	2,009575	

Font: authors

The difference in means through the statistical tests presented corroborates the validation of the teaching-learning methodology used in this study, showing its efficiency to promote Computational Thinking.

6.2 Computational Thinking and Students' Reasoning Ability

In order to verify the effect of the learning of Computational Thinking on the students' reasoning ability, we performed the analysis of the means of the gross results of the tests: VR – Verbal Reasoning, AR – Abstract Reasoning, MR – Mechanical Reasoning, SR – Spatial Reasoning and NR – Numerical Reasoning, which showed that there was an increase of the mean in all tests.

Considering the decision rule of the Shapiro-Wilk test, it was identified that, in this case, it is not possible to use the paired t-test to compare the means of the pre test and post test, since the sample achieved in the pre tests RV, RA and BPN5, does not follow a normal distribution. Analyzing the results of the post test, it was verified that in the RA and RV tests, it was not possible to reject the null hypothesis. For this reason, to standardize the statistical analysis of the means obtained in the reasoning tests, the Wilcoxon test was used to compare the difference of means.

Comparing the means obtained in the Verbal Reasoning test, the Wilcoxon test showed a statistically significant increase in the mean, with a significance level

of 5%. The students who attended the course have increased the score of this test between 0.5 and 2.5 points higher than the score of the first evaluation. These results are presented in Table 3.

Table 3: Verbal Reasoning Analysis

Information	Values
Statistic	806
P-value	0,0036
Null hypothesis	0
Lower limit	0,499974285
Pseudo-median	1,499974734
Upper limit	2,499952547
Trust level	0,95

Font: authors

Regarding the difference of means of the Abstract Reasoning test, the Wilcoxon test proved that the increase in mean is statistically relevant, with a significance level of 5%. In this test the students obtained a growth of around 1.5 points compared to the first test performed, as shown in Table 4:

Table 4: Abstract Reasoning Analysis

Information	Values
Statistic	814
P-value	0,0027
Null hypothesis	0
Lower limit	0,500039073
Pseudo-median	1,999999486
Upper limit	2,500061646
Trust level	0,95

Font: authors

The mean increase in the Mechanical Reasoning test was also verified using the Wilcoxon test with a significance level of 5%. For this test a score difference of 1.5 points with a margin of error of 1 point is expected, that is, the students who attended the course obtained an increase in the score of this test between 0.5 and 2.5 points higher than the result of the first evaluation. These results are presented in Table 5:

Table 5: Mechanical Reasoning Analysis

Information	Values
Statistic	726,5
P-value	0,0068
Null hypothesis	0
Lower limit	0,499976114
Pseudo-median	1,500079589
Upper limit	2,500008729
Trust level	0,95

Font: authors

The Wilcoxon test did not confirm the existence of score difference regarding the first and second evaluations of the Spatial Reasoning test since the p-value is higher than 0.05. The results of this test are shown in Table 6.

Table 6: Spatial Reasoning Analysis

Information	Values
Statistic	607
P-value	0,4683
Null hypothesis	0
Lower limit	-0,500038266
Pseudo-median	0,499933548
Upper limit	1,499944641
Trust level	0,95

Font: authors

The mean difference of the Numerical Reasoning test was not statistically relevant, since with the Wilcoxon p-value test it was higher than 0.05, not allowing rejection of the null hypothesis. Table 7 shows the results of this test:

Table 7: Numerical Reasoning Analysis

Information	Values
Statistic	718,5
P-value	0,0508
Null hypothesis	0
Lower limit	-7,64E-05
Pseudo-median	1,000038909
Upper limit	1,99997262
Trust level	0,95

Font: authors

When comparing the means of the set of reasoning tests, Wilcoxon's test showed a statistically significant increase in mean, with a significance level of 5%. Considering the margin of error, students who attended the Games Development Course obtained an increase in BPR-5 between 3.0 and 7.5 points higher than the result of the first evaluation. These results are presented in Table 8:

Table 8: BPR-5's Analysis of Means

Information	Values
Statistic	1015,5
P-value	1,00E-04
Null hypothesis	0
Lower limit	3,000005013
Pseudo-median	5,499951932
Upper limit	7,500006083
Trust level	0,95

Font: authors

Based on the results, it is possible to observe that the proposed course has favored a growth in Computational Thinking and students' reasoning.

6.3 Relationship Between Computational Thinking and Different Types of Reasoning

In order to analyze the relationship between Computational Thinking and the different types of reasoning: Verbal Reasoning, Numerical Reasoning, Spatial Reasoning, Abstract Reasoning and Mechanical Reasoning, the Pearson correlation was used.

According to Table 9, the Computational Thinking Test showed a correlation with all reasoning tests, reaching a very high correlation with the sum of the BPR-5 scores that was 0.74. This fact demonstrates that there is a very close relationship to Computational Thinking and a general factor of intelligence.

Table 9: Pearson Correlation

	CTT	VRT	ART	MRT	SRT	NRT	BPR5
Pre test		0,505	0,649	0,405	0,630	0,562	0,696
Post test		0,462	0,670	0,457	0,629	0,646	0,742

Font: authors

VII. CONCLUSIONS

The use of Román's Computational Thinking Test (2015) and the BPR-5 - Battery of Reasoning Tests are considered a differential of this study, since these instruments allowed the measurement of the Computational Thinking and the reasoning of the participant students in an objective way. Since the score in the Computational Thinking Test was significantly higher after the course, the results obtained allowed us to validate the present teaching methodology and infer about the possible benefits that should be obtained with its adoption in the Elementary School classrooms.

In this study it was not possible to use a control group, which would isolate external factors that could influence the development of Computational Thinking, however, as the experiment occurred in 7 weeks, this interval reduced the possibility of school learning to be responsible for observed increase. It should be noted that the methodology was used in 4 different classes, presenting an increase in Computational Thinking and different types of reasoning in all classes. Considering that the course editions occurred in different schools and in two consecutive years, this fact reinforces the role of the Games Development Course in the measured results, avoiding the hypothesis of being due to external factors such as school learning. In the present study all the classes of the Games Development Course were given by

the researcher himself, which facilitated the standardization of the classes. When replicating this experiment to the classroom it becomes relevant to pay attention to the lesson plan used and it may be necessary to have a greater detail to be replicated by a third party. The students did not receive the tests and did not have access to the results obtained until the end of the research. As the time interval used between the test and retest was 7 weeks, this time was sufficient to prevent students from remembering the questions used in the tests. It should be noted that in the precision studies of the BPR5 - Battery of Proofs of Reasoning Lemos (2006) used the interval of only 1 month between test and retest finding a correlation coefficient higher than 0.75

This work has confirmed that even brief interventions, such as the one used in this research, when prepared with an adequate methodology, can produce relevant effects for its participants. The fact that a 10-hour course produces changes in cognitive ability, which can be measured and statistically proven, confirms the importance of inserting content for the development of Computational Thinking in Brazilian schools.

Another relevant fact of this research was to demonstrate the correlation between Computational Thinking and other types of reasoning, reinforcing their importance in cognitive development. As the increase in Computational Thinking favored the development of Verbal Reasoning, Abstract Reasoning and Mechanical Reasoning, it is possible to conclude that the improvement in the cognition of the subject regarding the construction of Computational Thinking can favor the learning of other curricular components.

REFERENCES

- [1] Afonso, M. J. (2007). Paradigmas diferencial e sistêmico de investigação da inteligência humana: perspectivas sobre o lugar e o sentido do construto. Tese (doutorado em Psicologia – Psicologia Diferencial. Portugal: Faculdade de Psicologia e de Ciências da Educação, Universidade de Lisboa.
- [2] Almeida, L.S., & Primi, R. (2000). Baterias de Prova de Raciocínio – BPR-5. São Paulo, SP: Casa do Psicólogo.
- [3] Ausubel, D. P., Novak, J. D., Hanesian, H. (1980). Psicologia educacional. Tradução Eva Nick. Rio de Janeiro: Interamericana,
- [4] BBC learning, B. *What is computational thinking?* (2015). Retrieved on April 22, 2019, from <http://www.bbc.co.uk/education/guides/zp92mp3/revision>.
- [5] CODE.ORG. (2015). *Instructor Handbook - Code Studio Lesson Plans for Courses One, Two, and Three*. Retrieved on June 24, 2019, from <https://code.org/curriculum/docs/k-5/complete.pdf>.
- [6] Google for Education. *What is Computational Thinking?* Computational Thinking for Educators, 2015. Retrieved on June 24, 2019, from <https://computationalthinkingcourse.withgoogle.com/unit?lesson=8&unit=1>.
- [7] Grover, S., & Pea, R. (2013). Computational Thinking in K-12: A Review of the State of the Field. *Educational Researcher*. Vol 42, 1, pp. 38–43. <https://doi.org/10.3102/0013189X12463051>.
- [8] Lemos, G., Almeida, L. S., & Guisande, M. A. (2006). Bateria de Provas de Raciocínio: suas versões, validação e normalização. In L. Almeida et al. (Orgs.), *Actas da XI Conferência Internacional "Avaliação psicológica: Formas e contextos"* (pp. 73-80). Braga: Universidade do Minho.
- [9] Liukas, L. (2015). *Hello Ruby: adventures in coding*. Indiana: R.R. Donnelley & Sons Company.
- [10] Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.
- [11] Kolb, D. A. and Fry, R. (1975). *Toward an applied theory of experiential learning*; in C. Cooper (ed.) *Theories of Group Process*, London: John Wiley.
- [12] Papert, S. (1980). *Mindstorms: Children, Computers, And Powerful Ideas*. New York: Basic Books.
- [13] Primi, Ricardo. (2003). *Inteligência: avanços nos modelos teóricos e nos instrumentos de medida*. Avaliação Psicológica, Vol. 2, 1, 67-77. Retrieved on June 24, 2019, from http://pepsic.bvsalud.org/scielo.php?script=sci_arttext&pid=S1677-04712003000100008&lng=pt&tlng=pt. Access: 24 de jun. 2019.
- [14] Royal Society. (2012). *Shut down or restart: The way forward for computing in UK schools*. Retrieved on June 24, 2019, from <https://royalsociety.org/~media/education/computing-in-schools/2012-01-12-computing-in-schools.pdf>.
- [15] Román-González, M. (2015). Computational Thinking Test: Design Guidelines and Content Validation, In *Proceedings of the 7th Annual International Conference on Education and New Learning Technologies*. Barcelona, Spain: IATED, pp. 2436–2444 <https://doi.org/10.13140/RG.2.1.4203.4329>.
- [16] Román-González, M. (2016). *Códigoalfabetización y Pensamiento Computacional en Educación Primaria y Secundaria: Validación de un Instrumento y Evaluación de Programas*. Tesis Doctoral. Universidad Nacional de Educación a Distancia, Madrid, Spain, pp. 1-720.
- [17] [16] Román-González, M., Pérez-González, J.-C., & Jiménez-Fernández, C. (2017). Which cognitive abilities underlie computational thinking? Criterion validity of the Computational Thinking Test, *Computers in Human Behavior*, 72, pp. 678–691. <https://doi.org/10.1016/j.chb.2016.08.047>.
- [18] Wing, J. M. (2006). Computational thinking. *Communications of the ACM*, 49(3), 2006, pp. 33-35. <https://doi.org/10.1145/1118178.1118215>.

- [19] Wing, J. M. (2010). Computational thinking: What e
Why? Retrieved on June 24, 2019, from
<https://www.cs.cmu.edu/link/research-notebook>
computational-thinking-what-and-why.

Implementation of 5S in Test Engineering in a Manaus Industrial Pole Mobile Telephony Factory

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Abstract— *The industrial pole of Manaus follows the worldwide trend of engagement on the issue of continuous quality improvement, especially regarding the organization of work environments and the need for managers to do more with less. This view has become paramount at this time when the market is extremely competitive. This article describes in essence the fundamentals, concepts and benefits of implementing the 5S program in the field of test engineering of the electro -electronic pole in the field of mobile telephony, as well as the possibility of correcting failures and waste, motivating employees and seeking that the own collaborator, has how to produce with quality and low cost in an environment where it is realized maintenance of Pcb's for cellular.*

Keywords— *5S, Continuous Quality Improvement, Mobile Telephone Handset.*

I. INTRODUCTION

After the Second World War Japan was destroyed, the Japanese found through the 5S program from the 50's a way to recover and develop Japan [1]. With this program in place there was a fight against filth and disorganization in postwar Japanese entities. In Brazil, in order not to differentiate from the original words, the word *senso* was used to describe 5S, which are in Brazil the 5 senses, the words in Japanese to Portuguese are equivalent *Seiri* - Sense of use, *Seiton* - Sense of Ordination, *Seisou* - Sense of Cleanliness, *Seiktsu* - Sense of Health and *Shitsuke* - Sense of Self-Discipline.

According to [2], it also says that in essence, 5S generates a change of conduct that tends to mobilize the whole organization, thus the advantages of deploying 5S in one sector, and in the long run in the whole factory are numerous. It is possible to have immediate results, as is the issue mainly of the visibility of the work you are developing when using the sense of use, and in the long term as is the case of *Senso* self-discipline, for example the Japanese will teach the 5S culture to their children and discipline them in these principles, consolidating and extending into adulthood, in society and in the professional environment [3].

In order for the 5S program to be deployed at the KM (Fictitious Name) Plant, in the field of Test Engineering, there was a need due to the excess of time lost in searching for work tools, Excess materials in the area

dedicated to Jigs test, Out-of-use and scrap items taking up space for new and usable materials in the industry. It is necessary to develop the sense of urgency to make and maintain organized, material and functional sites [4].

The overall objective of this case study was to improve performance in the test engineering sector at KM Factory through the 5S program, aiming to meet with excellence the need of the production sector, thus encouraging employees to be able to implement the 5 steps, and to combat eventual losses and waste in the sector.

II. THEORETICAL FOUNDATION

In order to effectively carry out the research work, we sought to base the use of the 5S Program in the context of a process of quality improvement within the segment of the mobile telephony electric-electronic pole.

2.1 WHAT IS THE 5S PROGRAM?

The 5S Program is the set of five common senses: *Seiri*, *Seiton*, *Seiso*, *Seiketsu* and *Shitsuke* [5]. The 5S is the basis for the implementation of a well-structured management system that, with its practice, promotes continuous growth of people, a pleasant work environment and an improvement in the quality of life [6].

The aforementioned author also mentions that when 5S is applied in any organization, the environment is

prepared for profound changes and that generate visible and immediate results.

The 5S Program is the support for applying the quality program, and when well developed it is recognized as an excellent transformation tool in the organization [7].

All the people of the company, from the president to the operators, will have a great responsibility for change, everyone needs to be committed to achieving this through education and training.

The five senses according to [8], mean:

Seiri: The sense of use implies leaving only what is actually used in the work environment, the unnecessary tasks should also be eliminated, the frequency of the equipment being used must be analyzed.

Promote the "Clean or Discard" day when everyone should select the unnecessary items to perform their tasks and give a suitable destination to them [8].

Seiton: The sense of organization and the second phase of the 5s methodology. The Japanese word Seiton literally means "putting everything in order", so under this methodology means organizing materials, equipment and other necessary items so that anyone is able to find them easily and quickly [9].

Seiso: The sense of cleaning comes to eliminate dirt, more important than cleaning and not soil. This sense comes also in a preventive way seeking improvements and awareness, focusing on the clean environment is the one that is less dirty.

Seiketsu: The Sense of Normalization comes to systematize the new values and standards that the three senses Seiri, Seiton, Seiso. Seiketsu calls for the awareness and commitment of all leading to standardization.

Shitsuke: The sense of self-discipline seeks through awareness raising to encourage the collaborator to practice good deeds whether in relation to 5S, or in relation to continuous improvement.

It can be observed in figure 1, where shows examples of application of tool 5s.

Japanese Term	English Equivalent	Meaning in Japanese Context
Seiri	Tidiness	Throw away all rubbish and unrelated materials in the workplace
Seiton	Orderliness	Set everything in proper place for quick retrieval and storage
Seiso	Cleanliness	Clean the workplace; everyone should be a janitor
Seiketsu	Standardization	Standardize the way of maintaining cleanliness
Shitsuke	Discipline	Practice 'Five S' daily - make it a way of life; this also means 'commitment'

Fig. 1: Example of application of 5s. Source: [10].

For [11] there are several positive results with the implementation of "5S" as an improvement of the working environment, standardization of procedures, cleaner and more comfortable environment, saving time

and effort, eliminating unnecessary paper and objects, improving layout for greater use of space, improvement of internal communications and greater participation of employees to achieve the success of the 5S program in the company.

With the implementation of the 5S in a company or in a sector and possible to verify that people will have changes in their lives, in the behavioral side, because the discipline of the acquired culture helps in that improvement.

It is expected that differences in productivity, efficiency and employee satisfaction will also be observed, as well as physical results, such as improvement in the internal space of the company, with the elimination of equipment that is obsolete.

2.1.2. Audit of 5S

According to [12], auditing is responsible for analyzing and assessing the performance of an organization, in whole or in parts, with a view to formulating recommendations and comments that will contribute to improving the economy, efficiency and effectiveness aspects.

The audit becomes necessary to measure the current 5S standard to then evaluate the changes, serve as feedback for evaluation of the implementation plan or the action plans.

According to [13], "We do not manage what is not measured, we do not measure what is not defined, we do not define what we do not understand, and there is no success in what we do not manage."

2.2 PROCESS OF CONTINUOUS IMPROVEMENT OF QUALITY

Continuous Improvement establishes in its vision that no product, process or service is so good that it can not be improved, that is, it aims at constant improvement.

In the nineteenth century, in the introduction of the assembly line concept at Ford Motor Company, continuous improvement gained importance. In 1948, in Japan, the continuous process improvement that would change the trajectory of large-scale productions began to emerge. Lean Thinking, derived from the Japanese Continuous Improvement, can now be seen in many companies.

Implementation Steps for continuous process improvement. Solutions for a Model that can be used:

- The PDCA Cycle;
- Kaizen Method;
- Lean Thinking;
- Six Sigma.

Of these four tools, only the PDCA Cycle was used to implement the 5S in the field of Test Engineering, below is an explanation.

2.3 CONCEPT OF PDCA

The PDCA, figure 2, is an American origin management methodology, in the 1930's it was developed by Engineer Shewhart, but it was Deming who disclosed the method and made the PDCA known initially in Japan and then worldwide, through four words in a cycle using Plan, Do, Check, Act.



Fig. 2: PDCA Cycle, Source: adapted from [14].

- Plan: Identify the problem, analyze and elaborate the plan of action to achieve the goals.
- Do: Implement Action Plans, perform quality assurance, meet standards.
- Check: Control the effectiveness of the action plans, always watching the work, in order to follow the results obtained.
- Act: Act correctively if necessary, act with standardization, review of activities and planning.

2.4 MANAUS INDUSTRIAL POLO IS THE KM FACTORY

The Industrial Pole of Manaus (PIM), in Brazil. It was created by decree-law number 3173 of June 6, 1957 and improved ten years later. In 1957, with the predominance of the electro-electronic sector, multinational companies aimed to guarantee the mass production of final consumer goods.

According to [15] the PIM brought together more than 600 cutting-edge industries in the Electroelectrical, Two Wheels, Naval, Mechanical, Metallurgical and Thermoplastic segments, among others, which generate more than half a million direct and indirect jobs. The indicators of billing and production of the incentive park of Manaus are increasing each year, having billed in 2012 values over US \$ 37 billion.

The KM Factory, in which the 5S program was implemented in Test Engineering, was located in the industrial hub of Manaus, belongs to the electro-

electronic pole, its Production is focused on Mobile Telephony, The factory has 500 employees, to supply the demand of 7 models of cellular devices that the factory produces.

III. TOOLS AND METODS

The tools used to compose the improvement actions were Excel spreadsheets, Presentations and Power point, periodic meetings during the implementation, at the end of the implementation of the 5S in the sector was selected an audit team to be trained to perform correctly verification of conformities and nonconformities using the Checklist.

In the Analysis of Results, in the verification items considered problematic, the 5W2H tool was used, which consisted in analyzing the root cause of the problem, through the seven questions: What, Why, Where, When, Who, How, How Much.

3.1 VERIFICATION SHEET FOR 5S EVALUATION

The Checklist is part of the 7 statistical tools for quality control, very simple to apply also known as Checklist, or list of defect recall. The first step at the beginning of most process controls or efforts to troubleshoot. The Checklist makes it possible to control the execution of tasks and their subsequent evaluation.

The following is a step-by-step guide on figure 3 on how to construct and define the purpose of data collection using the check sheet:

Reason	Day					Total
	Mon	Tues	Wed	Thurs	Fri	
Wrong number						20
Info request						10
Boss						19
Total	12	6	10	8	13	49

Fig. 3: Information on how to build the Check Sheet, Source: Adapted from [16].

IV. IMPLEMENTATION OF THE 5S

presentation to the Supervisor of the Engineering area of test Rogerio gato, responsible for the team, requested the necessary authorizations for the implementation, and authorizations granted by the same. The research project was implemented through a case study that began with a planning stage where an implementation schedule was defined, identifying the action, the person on responsible and the time of execution.

The PDCA Cycle, which has four steps, 1- Plan, 2- Do, 3- Verify, 4- Act, will be addressed by explaining each task performed in the deployment.

4.1 PLAN

In this phase, Team 5S was defined, this team was responsible for planning the implementation, the team

evaluated several problems in the sector, such as equipment disorder, obsolete material along with materials in use, lack of labeling and control in the shelves. Computer workspace extremely messy, being that we only had two computers for staff to use in the maintenance area. Work tools totally out of place, generating wasted time in solving some problem in the productive area. With several photos of the Sector was made a presentation to show employees the current state, also set the weekly Action plan in a meeting with the entire 5S team.

ITEMS	PDCA	TASK NAME	DAYS
1	Plan	Team Definition	1
2	Plan	Industry Assessment	2
3	Plan	Preparation of the Presentation	1
4	Plan	Action Plan	2

Fig. 3: Planning Step

4.2 Do

After the preparation of the Weekly Action Plan by the 5S Team, we sent the document to be approved by the Supervisor, the first action after the approval, was to mark the date of the presentation for the employees of the sector, in this presentation was approached the 5S Program, the situation current sector of the industry through photos and the Weekly Action Plan created by the 5S team, the employees visualized the need for change, as the factory had three different shifts, Team formation among employees became necessary, There was also a material request for the beginning of activities, after the material was released, we began the deployment with the Sense of Use.

ITEMS	PDCA	TASK NAME	DAYS
5	Do	Meeting for implementation	1
6	Do	Team building	1
7	Do	Request Materials	2
8	Do	Implementation - Start of activities	5
9	Do	Implementation - (Ordinance)	5
10	Do	Implementation - (Cleaning)	5
11	Do	Implementation - (Health)	5
12	Do	Implementation - (Self-discipline)	5
13	Do	Disclosure of Results	1

Fig. 4: Step Do

4.2.1 Week of Sense of Use

In the first week of project execution the command was to separate what is useful from what is not, to improve the use of what is useful, to keep only what is needed in the workplace, to fight waste. Before the Week of use, it was possible to find several empty boxes in the sector taking up space on the shelves, many unused equipment for productive area. In Figure 5, an analysis of the equipment was made, and many of them were sent to the sector responsible for obsolete equipment.



Fig. 5: Activity carried out in the first week (Organization of shelves).

4.2.2 Ordinary Sense Week

In the second week, it was the turn of the Sense of Ordinance, presented in figure 6. The organization, in this sense, referred to the arrangement of tools and equipment in an order that would allow the best flow of work. Tools and equipment were left in the places where they will be used later. The process was done in order to eliminate unnecessary movements.



Fig. 6: Application of the sense of orderliness

4.2.3 Cleaning Sense Week

In the third week, the Sense of Cleanliness shown in Figure 7, began to be used, throughout the sector was already visible along with the other senses the difference everywhere. At this stage it was important not only to perform the cleaning of the environment, but also to maintain it. The time has come to educate us not to get dirty, and to watch over everything that is our responsibility.



Fig. 7: Application of Cleaning Sense

4.2.4 Week of Health Sense

In the fourth week, the Health Sense was implanted, with him the challenge was to keep what was already clean and organized, favoring the physical, mental and emotional health, from practices of hygiene. A meeting was also held for suggestions and praise, reinforcing a Harmonious work environment.

4.2.5 Self-Discipline Awareness Week

By the fifth week, the Sense of Self-discipline was already present, since in other senses this practice had already been stimulated, for the fact that every week,

Having a climbing team, for the organization and monitoring of the work environment, helped a lot to keep everything that had been done. Also every Monday was collected the major changes to be made in the current week, on Friday was collected the results (photos), and we sent to the whole team.

4.3 CHECK

For maintenance of the 5S Program, a group was set up to carry out audit training with the SGI (Person in charge of the Integrated Management System), so that there was control and monitoring of the development of the implementation.

The audit took place seven days after the meeting to disseminate the results of the implementation, through a Checklist, shown in figure 8, produced by the SGI, where all 5S items that had been implemented were analyzed.

The results achieved were very gratifying, although we did not have the highest grade, but the team was able to pass the Audit.

ITEMS	PDCA	TASK NAME	DAYS
14	Check	Training for Auditors	3
15	Check	Creation of checklist for SGI audit	3
16	Check	Application of Audit in the sector	2

Fig. 8: Step Check

4.4 ACTION

After the Audit, there was a meeting with Team 5S, Auditors and SGI where the results were discussed and also decided the time that a new audit would be performed, it was decided at that meeting that the Audits would be held once a month for the continuity of the program and adaptation of employees to the new reality.

Check items in which employees had larger grades would be added to the list of standardized items, check items that had smaller grades would be treated as problem points, 5W2H were applied to these items to get closer to solutions. Figure 9 shows the action step, with the solutions found a new Action Plan was defined so that

employees had the opportunity to achieve better scores in the next audits.

ITEMS	PDCA	TASK NAME	DAYS
17	Action	Analysis of audit results, meeting to define new action plan	2

Fig. 9: Step Action

The results of the deployment will be presented.

V. ANALYSIS OF RESULTS

Through the verification of Figure 10, it is possible to analyze that the results of the first Audit were between 80% and 90%, Performance considered Good.

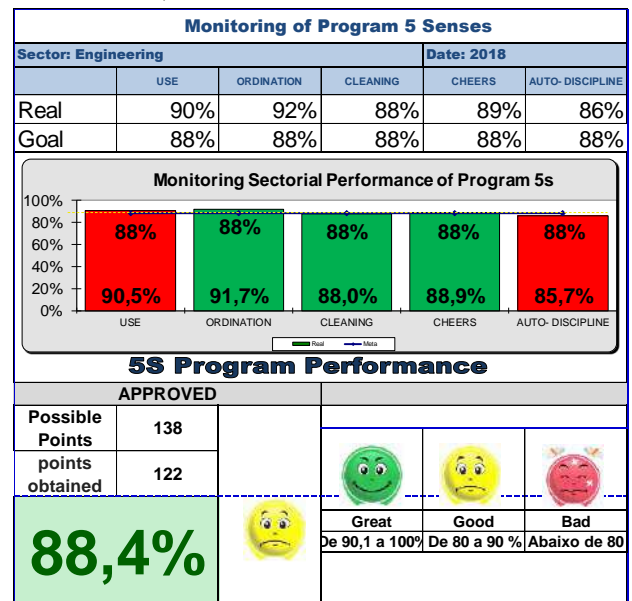


Fig. 10: Result of the first audit

It is possible to visualize all the verification items used to carry out the Audit, during the Audit we had four items of verification, which were considered problematic items, two items of the sense of use and two items of the ordering sense, these items, before the application of the Program 5S were already quite critical items. Below in Figure 11, the following check items found that at least one nonconformity was detected relative to the item in question:

VERIFICATION ITEMS	Punctuation			
	0	1	2	3
SENSO OF USE				
4- Removal of leftovers from materials, reworked products etc. from the workstation.			2	
6- Items in good operating condition, but not used in the environment. Could have been discarded.			2	
SENSATION OF ORDINATION				
3- Properly Wired / Properly Wired			2	
5 - Cabinets and Archives well organized, coinciding with the external identification and without excess of			2	
Standard for 5S Program Evaluation		Punctuation		
.No non-compliance was detected in the item being evaluated		3		
.At least one nonconformity was detected in relation to the item in question.		2		
.At least two nonconformities related to the evaluated item were detected.		1		
.More than two nonconformities related to the item evaluated were detected.		0		

Fig. 11: Problem Check Items

For the treatment of items with nonconformity, after the 5W2H and on-site investigation, it was analyzed that item four and six of the sense of use used to occur in the employee shift exchange, for these items standard operating procedures were created, in addition to the call via e-mail to stimulate the containment of the problem, even so the procedures regarding these items were not followed.

In item three, we did not have any problems after the call via e-mail, but in item six, there was a great resistance from the employees, especially on the days when action that the 5S Team took in relation to this item was that on the days of product exchange on the lines, a control report was signed by the executing employee. So it was possible to better track who was not complying with the procedure is to direct the point of attention.

Several campaigns within the sector were carried out, so that in the next audits the standardization items would continue with a high score, and that the problematic items would be remedied.

VI FINAL CONSIDERATIONS

Specifically the implementation of the 5S program took place in the test Engineering sector, where the employees performed the maintenance work of the production test jigs. The application of the 5S Program contributed immensely with the development of the sector through the improvement of the work environment, giving employees more agility in the flow of their activities.

During the implantation several resistances were found, mainly with the company's older employees, the thought "I am like this and I will die like this" was addressed to us in many moments. But the cultural

changes take time and effort, but were overcome with the help of all of the 5S team.

The main difficulties encountered were when the team was doing maintenance in the production area and carrying many work tools, the return of these tools almost always was not done in an organized way. It was possible to visualize this, because the employees of other shifts complained a lot of this fault, also when there were changes of product in the production lines, almost always the equipment did not return to the places of origin, due to the little space of the sector, we had to always request a readjustment of the labels for identification of such equipment.

The environment after 5S was really very pleasant, the sector began to breathe an air with more cleaning. Some difficulties were overcome, others really only with the analysis time, for possible adjustments. The Program demanded of every employee constant self-discipline, respect for standards and procedures was a great victory for Team 5S, and certainly a gain in productivity and elimination of various wastes that were occurring in the industry.

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REFERENCES

- [1] LINS, Bernardo E. Breve história da engenharia da qualidade. Cadernos Aslegis, v. 4, n. 12, p. 53-65, 2000.
- [2] DA SILVA, João Martins. 5S: o ambiente da qualidade. FCO, 1994.
- [3] RIBEIRO, Haroldo. 5S: um roteiro para uma implantação bem sucedida. Quality House, 1994.
- [4] DOMINGUES, Marcos Aurélio. A importância do programa 5S para a implantação de um sistema da qualidade. 2011.
- [5] MENDONÇA, Magno Da Silva et al. Análise da eficácia da implantação do programa 5s: um estudo de casos em uma indústria moveleira. Perspectivas Online, v. 4, n. 13, p. 20-35, 2010.
- [6] CAMPOS, Renato et al. A ferramenta 5S e suas implicações na gestão da qualidade total. Simpep– Simpósio de Engenharia de Produção, v. 12, 2005.
- [7] GRAEL, Paulo Fernando Fuzer; OLIVEIRA, OJ de. Sistemas certificáveis de gestão ambiental e da qualidade:

- práticas para integração em empresas do setor moveleiro. *Produção*, v. 20, n. 1, p. 30-41, 2010.
- [8] PALADINI, Edson Pacheco. *Gestão da qualidade: teoria e prática*. In: *Gestão da qualidade: teoria e prática*. 2010.
- [9] OAKLAND, John. *Gerenciamento da qualidade total*. NBL Editora, 1994.
- [10] GAPP, Rod; FISHER, Ron; KOBAYASHI, Kaoru. Implementing 5S within a Japanese context: an integrated management system. *Management Decision*, v. 46, n. 4, p. 565-579, 2008.
- [11] GRECO, Rosângela Maria et al. A organização do ambiente de trabalho com o método 5S—cuidando da saúde do trabalhador. *Revista Ciência em Extensão*, v. 8, n. 3, p. 303-307, 2012.
- [12] ANDRADE, Paulo Hyder da Silva et al. *O impacto do Programa 5S na implantação e manutenção de sistemas da qualidade*. 2002.
- [13] DEMING, W. Edwards. *Out of the Crisis*. MIT press, 2018.
- [14] MOEN, Ronald; NORMAN, Clifford. *Evolution of the PDCA cycle*. 2006.
- [15] GALO, M. *Polo Industrial de Manaus, SUFRAMA*, 2017.
- [16] VIEIRA, Sonia. *Estatística para a Qualidade*. Elsevier Brasil, 2016.

Neutralization Potential (NP) of a Porcelainate Production Alkaline Waste in the Prevention of AMD Generation

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Abstract—In the Coal Mining Region of Santa Catarina is located the largest pole producing ceramic floors in Brazil. Considering the large volume of alkali feldspar rich waste that is generated during the porcelain polishing step. The ceramic industry is great generator of solid waste, usually deposited in landfills, being responsible for the pollution of extensive areas. There is a great availability of this alkaline material that can potentially be used as a neutralizing agent to prevent the generation of AMD in the coal mining. In this work the characterization of the potential of the generation of DAM through static and kinetic tests of a coal waste obtained in a beneficiation plant of the coal mining region, was characterized chemically the waste originated during the step of polishing in the production of porcelain tiles and determined the neutralization potential of the alkali feldspar waste. The results indicate that the coal mining waste presents a high potential of acidity (AP), the waste of the production of porcelainates presents as a major component of its composition silicon oxide and aluminum oxide, but also other oxides such as of potassium and has a moderate neutralization potential (NP). The results indicate a moderate potential of use as an alkaline additive in the prevention of AMD generation. However other uses are recommended, such as the production of soil-cement with this waste.

Keywords—Porcelain, Wastes, AMD, Prevention.

I. INTRODUCTION

Acid Mine Drainage (DAM) comes from the natural oxidation of sulfide minerals when in contact with air and water. DAM is associated with coal mining and polymetallic sulphides, especially in the presence of iron sulphide (pyrite or marcassite - FeS₂). These sources remain active for decades and even centuries after their production [1, 2, 3, 4].

The Carboniferous Region of Criciúma, in Santa Catarina, is highly affected, being considered one of the 14 most polluted areas in Brazil. The improper management of these wastes, practiced in the past, and in certain cases even in the current activities, resulted in the formation of an AMD contaminating soil and water with low pH and a high concentration of sulfate, iron (II and III), aluminum, zinc and manganese [5].

It is estimated that, in the Carboniferous Basin of Southern Santa Catarina, there are about 786 km of rivers

affected by DAM in the Araranguá, Tubarão and Urussanga Rivers basins. The contamination of water resources is due to 134 areas mined in the open air amounting to 2,924 ha, 115 areas with waste deposits to 2,734 ha, 77 acidic lagoons amounting to 58 ha, as well as hundreds of underground mines [5, 6, 7].

II. PREDICTION OF THE ACID DRAINAGE GENERATION

The pressure from environmental agencies, public ministry, the community at large and awareness of the Carboniferous are promoting a major joint effort to minimize the environmental problem. An important tool in this context is the need to forecast the generation of DAM by the materials handled in the mining activities and mainly by the tailings of the beneficiation. The DAM prediction through static and kinetic tests has been applied worldwide for decision-making in mining enterprises [2, 8, 9]. However, these methods have not been applied in the Carboniferous Region of Criciúma.

The static tests have the purpose of evaluating the potential of generation of AMD by a certain material. They are easy and fast and allow the application of specific criteria that allow the classification of the samples according to their potential for acid generation. Afterwards, the materials are subjected to a series of kinetic tests that will determine the acid generation behavior over time, as well as the expected quality of drainage [8].

The usual kinetic tests are performed on Soxhlet reactors, agitated flask techniques, humidity cells and column leaching tests. Although there is no standardized method, the most popular laboratory kinetic assay is that of moisture cells [10]. In-situ tests on stacks are also employed. Kinetic tests require a long time, ranging from weeks, months or even years. Based on the results of the static and kinetic tests, appropriate mathematical models can be applied in order to extrapolate the results over a period of years, decades or even centuries.

AMD is due to an autocatalytic reaction. Thus, the best method of control is not to generate it. The use of alkaline additives in mixture with pyrite wastes is a technique recognized as a preventive method for the generation of DAM and little (or none) has been applied in the coal region of southern Brazil.

Sintered porcelain ceramics, known as porcelain tiles, are a class of ceramic products used for coatings. The porcelain stoneware is the ceramic for coatings that presents the best technical and aesthetic characteristics when compared with the others found in the market. Due to its properties this material has increased its participation in the market of ceramic material. The ceramic mass of porcelain tiles requires a proportion of feldspar up to 50% of the ceramic mass.

III. METHODS

The methodology of the work within the context of the prediction of DAM was initially restricted to the static test of determination of the ABA Neutralization Potential by the SOBEK and modified SOBEK method, to the kinetic test with moist cells.

3.1 Samples of coal tailings

The materials studied were collected directly from coal beneficiation plants of the Carboniferous Region of Santa Catarina. Samples of coal generated in beneficiation operations were sampled. The samples were conditioned, transported and prepared for the static and kinetic tests.

3.2 Samples of alkaline residues

The alkali feldspar rich were supplied by Cerâmica Eliane S / A. Only this company produces approximately 1000 tons of this waste per month, and is currently destined for grounding. The samples were conditioned, transported and prepared for the static and kinetic tests.

3.3 Static Tests - "Acid Basic-Accounting (ABA)"

The static tests to be implemented were the acid and base accounting procedure developed by Sobek [9]. It is an essay that aims to determine the balance between acidity production and acidity consumption (neutralization) by the mineral components of a sample. The test involves calculating the sample's acidity potential (AP) from measurements of sulfur concentration and the measurement of neutralization potential (NP) [8].

From this data will be calculated:

$$\text{- net neutralization potential (NNP) = NP - AP}$$

$$\text{- neutralization potential ratio (NPR) = NP / AP}$$

- where AP, NP and NNP are generally expressed in kg CaCO₃ / t sample.

The procedure for the determination of the acidity potential (AP) will be from the total sulfur content (Sobek) or pyritic - FeS₂ (Modek Sobek). Stoichiometrically, one mole of CaCO₃ is required per mole of S:

$$\text{AP (kg CaCO}_3 \text{ / t sample) = (1000/32) x weight\% S}$$

The Neutralization Potential Determination was performed by attacking the sample with acid heated at 90°C to consume the neutralizing minerals and titration with NaOH to pH 7.0.

$$\text{NP (kg CaCO}_3 \text{ / t sample) = (HCl cons., G / g sample) x (50/36.5) x 1000}$$

The ABA criteria for identifying the acidity potential of the materials are (NNP and NPR):

NNP values less than - 20 will form acid

NNP values above + 20 will not form acid

NNP values between -20 and + 20 are difficult to verify potential.

NPR values less than 1: 1 indicate the likely generation of AMD

NPR values between 1: 1 and 2: 1 indicate the possible generation of AMD

NPR values between 2: 1 and 4: 1 indicate that AMD is not expected

NPR values greater than 4: 1 indicate that DAM was not generated.

3.4 Characterization and Neutralization of a Acid Mine Drainage (AMD)

The treatment of a sample of acid mine drainage (DAM) was carried out by the addition of porcelanate powder under mechanical agitation in jar test equipment. The DAM used in the tests was collected at the same mine that provided the coal mining tailings for the experiments.

To characterize the acid mine drainage sample, the pH and concentration of iron, manganese, zinc, aluminum and sulfate were analyzed. The metals were analyzed in an Agilent brand AA-240 atomic absorption spectrometer, while the sulfate was determined by the turbidimetric method using a Hach turbidimeter. These analyzes were carried out at the Environmental Studies Laboratory for Metallurgy and followed the procedures of the Standard Methods for Water and Wastewater Analysis [11].

IV. RESULTS AND DISCUSSION

The following results were presented in the characterization tests of the materials, coal mining tailings and porcelain powder. As well as the neutralization potential (NP) of the porcelanate powder residue, aiming to evaluate its applicability in the treatment of AMD or in the prevention of its generation. It was also evaluated the potential of generation of AMD by the mining tailings used in the work.

4.1 Mineralogical Characterization of Materials

Initially the characterization of the materials used in this work, mining tailings and porcelain powder was carried out. For mineralogical characterization, the X-ray diffraction technique was used. The analyzes were performed on a Siemens D5000 X-ray diffractometer. The following are the diffractograms (Fig. 1).

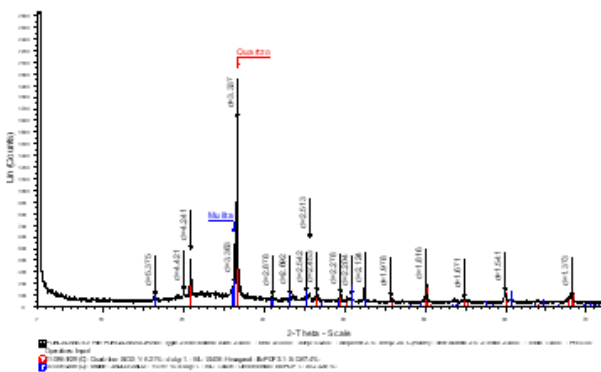


Fig. 1: X-ray diffraction of Porcelanate Powder.

The results show that the majority phases are the silicon and silicon oxides, also showing a peak for a potassium feldspar. The results indicate that the material may present a potential for alkalinity generation. Then, the X-ray diffraction analysis of the coal mining material was carried out. Below we can observe the diffractogram (Fig. 2).

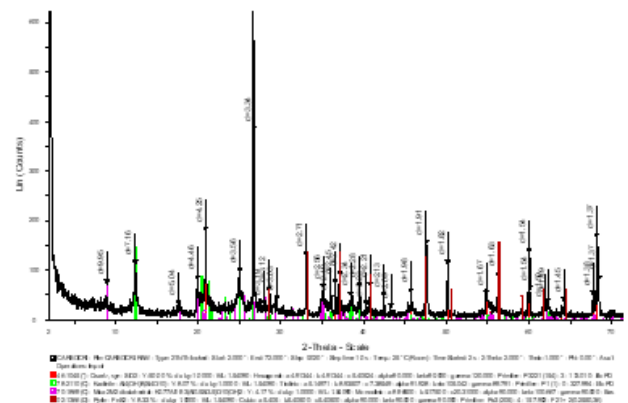


Fig. 2: X-ray diffraction of Coal Mining Reject.

The results obtained show the presence of silicon and aluminum oxides, but also a large amount of pyrite. This indicates that the material has the potential to generate acidity.

4.2 Determination of Net Neutralization Potential

Table 1 presents the results obtained in the tests to determine the neutralization potential of the material originating from the porcelain tile production. Performed according to the ABA methodology.

Table 1: Results of the Tests of Determination of the Neutralization Potential of Porcelanate Powder

Static Test	Results	
In Paste pH	8,57	
Total Sulfur (%)	0	
AP (kg CaCO ₃ /t)	0	
NP (kg CaCO ₃ /t)	30,70	
ABA	NNP	30,70
	NPR	30,70
	AMD formation	No

The results obtained in the step of determining the neutralization potential of the analyzed samples, demonstrates that the material has a relative capacity of neutralization. Featuring reasonable potential for use with the alkaline agent in preventing the generation of AMD.

Also, the tailings produced during the process of concentrating the coal from the Barro Branco layer of the State of Santa Catarina were analyzed. The results obtained are shown in Table 2.

Table 2: Results of coal wastes characterization analyzes

Parâmetros analisados	Rejeito de carvão antes do processo de lixiviação
Ash (%)	80,4
Volatile matter (%)	12,4
Fixed Carbon (%)	7,2
S total (%)	9,7
S pyritic (%)	9,6
S sulphatic (%)	0,1
S organic (%)	ND
Pyrite (%)	23,0
AP (kg CaCO ₃ t ⁻¹)	304
NP (kg CaCO ₃ t ⁻¹)	0
NNP (kg CaCO ₃ t ⁻¹)	- 304
C (%)	5,3
H (%)	1,0
N (%)	0,1

The results obtained demonstrate that the material has a very high acidity potential. This indicates potential for generation of AMD. The NNP value is equal to -304, which according to the ABA criteria indicates potential for the generation of AMD.

4.3 Kinetic Generation Assays of AMD

Kinetic prediction of the generation of AMD was carried out using the materials used in this work. From the results obtained in the analyzes of the Liquid Neutralization Potential (NNP) of the porcelain powder and the Acid Generation Potential (AP), the mass mixing ratios were determined. The ratio obtained between the porcelain dust mass and the coal tail is approximately 10 times, then static tests were performed with the raw material, with a mixture of 10 parts of porcelain powder and one part of coal tailings, were also 15 parts of porcelain tile powder and one part of coal mining tailings were used. The results indicate what the results of the static tests pointed out, that is, if the coal mining tailings are inadequately deposited in the environment, acidity will occur. And we can classify this waste as high-power generating AMD.

Assays with one part of tailings from coal mining added to 10 parts of porcelain powder indicate that it greatly reduces the potential for acidity generation. Even so there is release of acidity by the material, which indicates that this mass ratio still produces acidity. When a higher proportion of porcelain powder material was used, the

potential for acidity generation was greatly diminished, even though in a few weeks the pH became slightly acid. The obtained results indicate that this mass mixing ratio can be used to avoid the generation of AMD.

V. CONCLUSION

From the results obtained in the present work, it can be concluded that:

Coal mining in Brazil generates millions of tons of coal tailings, rich in pyrite, that generate DAM with great environmental impact. To solve this problem, companies have invested in effluent treatment plants, with high operating costs. However, an alternative to this operational procedure is the adoption of the practice of alkaline additives in coal mining tailings, thus preventing the generation of this serious environmental problem.

The porcelain powder was efficient in preventing the generation of DAM, however the ratio of porcelain powder / coal waste mass is quite high.

Also the porcelain powder can be used as a source of alkalinity in the treatment of acid effluent (DAM), however the dosages should be studied aiming at a lower generation of sludge in the treatment process of AMD.

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REFERENCES

- [1] Fernandez-Rubio, R.; Lorca, Sergio F.; ARLEGUI, Jorge E. Abandono de Minas Impacto Hidrológico, Universidad Politécnica de Madrid, 1986, 267p.
- [2] Kontopoulos, A. Acid Mine Drainage Control. In: Effluent Treatment in the Mining Industry. Castro, S.H.; Vergara, F.; Sánchez, M.A (Eds.). University of Concepción, 1998.
- [3] Capanema, L.X.L.; Ciminelli, V.S.T. And investigation of Acid Rock Drainage (ARD) occurrence in a gold mine located in a southeastern Brazil region. REM, v.56, n.3, p201-206, 2003.
- [4] Johnson, D.; Hallberg, K.B. The microbiology of acidic mine waters. Research in Microbiology, v.154, p.466-473, 2003.
- [5] Gomes, C.J.B. Projeto para Recuperação Ambiental da Bacia Carbonífera Sul Catarinense de Santa, Relatório de Atividades – fev. de 2004, www.siecsc.com.br/meioambiente.
- [6] De Luca, S.. Medidas Corretivas e Preventivas de Impactos da Mineração de Carvão In: Carvão Mineral II. Ed.Porto Alegre: UFRGS, 1991.

- [7] Menezes, C.B.T.; Nosse, E.O.; Nascimento, T.L.; Santos, M.G.S.; Ricken, C. Pesquisa e Desenvolvimento de Metodologias para o Controle de Drenagem Ácida e Tratamento de Efluentes da Indústria Carbonífera – Convênio UNESC/IPAT – COOPERMINAS – Relatório Final, 2000, 183p.
- [8] EPA. Technical Document. Acid Mine Drainage Prediction. EPA530-R-94-036, 1994. 48p.
- [9] Sobek, A.A., Schuller, W.A, Freeman, J.R., Smith, R.M. Field and Laboratory Methods Applicable to Overburden and Minesoils, EPA 600/2-78-054, 1978. 203p.
- [10] ASTM. Standard Test Method for Accelerated Weathering of Solid Materials Using a Modified Humidity Cell. ASTM D 5744 – 96.
- [11] APHA - AMERICAN PUBLIC HEALTH ASSOCIATION – Standard Methods for the Examination of Water and Wastewater. Washington: APHA, AWWA, WEF. 20. ed., 2005.

Effects of Temperature and Cationic Surfactant on the Clarification of Sugar Syrup by Air Dissolved Flotation

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Abstract— Impurities responsible for color and turbidity of dissolved crude crystal sugar in water can be separated by dissolved air flotation (DAF) process according to a specified refined sugar. Clarifying agents help to adsorb and precipitate these impurities forming precipitates, which adhere to micro bubbles generated by injected pressurized air, forming agglomerates that float and are removed from the surface. Experiments of DAF were conducted using cationic surfactant (150, 225 and 300 ppm), to clarify sugar syrup at 66°Brix, at temperatures of 26, 40 and 55°C, 895 kPa pressure, 300 s agitation, followed by 2 hours of phase separation. The clarification of sugar syrup was judged by physicochemical analyzes of conductivity, color, turbidity and filterability. The best result was obtained with 225 ppm clarifying agent and 40°C resulting 36% color and 98% turbidity removal, a 50% increase in the rate of filterability, although with 32% increase in ash content. The study has demonstrated that color and turbidity can be removed and filterability rate can be increased for the clarified sugar syrup by DAF process using only a cationic surfactant without adding any other chemical agent, and conducting the process at a relatively low temperature.

Keywords— Clarify sugar syrup, Micro bubbles, sugar cane, sugar cane refinery, sugar syrup.

1. Introduction

The process of dissolved air flotation (DAF) starts by generating and introducing air under pressure into the liquid medium, followed by sudden reduction in pressure and the generation of micro bubbles. Air is injected into the liquid through a saturator under pressure, and after saturation, the mixture is injected in the flocculation tank at atmospheric pressure, where the excess of dissolved air is released in the form of micro bubbles, which in turn adhere to the solid phase precipitated in the liquid medium, forming agglomerates of particles and micro bubbles. These agglomerates float to the surface due to their lower density, from which they are easily removed as foam (CREMA, 2012; CREMA-CRUZ, 2017).

The main task of a sugar cane refinery is to remove the color and reduce the amount of impurities (non-

sugars) present in the crude sugar crystals, used as starting material, in order to produce a commercial sugar with a higher degree of purity. For the refining process, crude crystal sugar is dissolved in water, resulting in a dense solution, called "sugar syrup" or sometimes "melt liquor", with the purpose of diluting the residual film (mother liquor) surrounding the crystals, facilitating the clarification by flotation and subsequent process steps to the production of refined sugar (RIBEIRO, 2003; REIN, 2013).

Among the various unit operations involved in the production of refined sugar, the clarification of the sugar syrup is of major importance, with great influence in the manufacture of sugar, not only on the quality and product application performance, but also on subsequent production steps (REIN, 2013). The objective of the

process is to obtain a limpid, clear syrup by coagulation, flocculation and subsequent removal of impurities (non sugar) suspended and dispersed, responsible for the increased color and turbidity, and products with low purity and quality (JENKINS, 1966, REIN, 2007).

The coagulation is a process consisting of two subsequent phases. In the first stage coagulation occurs by adding chemical coagulants to reduce the repulsive forces between particles in suspension. In the second phase, flocculation occurs due to collisions between destabilized particles by coagulation, forming larger particles (RICHTER, 2009).

The principle for color removal from sugar syrup by refineries is based on cationic charged added molecules that interact more strongly with the anionic organic impurities, present in the syrup, than the added Ca^{2+} in the liming process (DOHERTY, EDYE, 1999). For this purpose, it is used cationic surfactants (mainly containing active polyamine), known as color precipitating (or decolorizing) because positive charges combine with the colored compounds, generally negatively charged at processing pH (COPERSUCAR, [199-?]; REIN, 2013). Moreover, in almost all flotation processes, selective hydrophobicity of the particles is achieved by adsorption of surfactants to make the hydrophilic surfaces of particles into hydrophobic surfaces, which are easily attached to the inserted air micro bubbles, by presenting a net negative charge due to adsorption of negative ions (HOLMBERG et al., 2002).

Cationic surfactants have been developed (Talofloc®, Cyanamid®, Talomel®, etc.), with the purpose of precipitating color compounds in the syrup. The mechanisms for the precipitation are quite similar, but with the different and restrictive dosages according to the Food and Drug Administration (FDA) (CHOU, 2000; REIN, 2013). Other methods (liming, phosphatation, carbonation, etc.) are widely applied to assist the removal of non sugar compounds present in sugar syrup. Cationic surfactants promote changes in surface charges of the compounds of non-sugars, promoting coagulation and flocculation. Furthermore, the clarification process is typically conducted at high temperature (nearly 82°C), however, the exposure of the syrup to high temperature for a certain time and low pH may result in loss due to sucrose inversion.

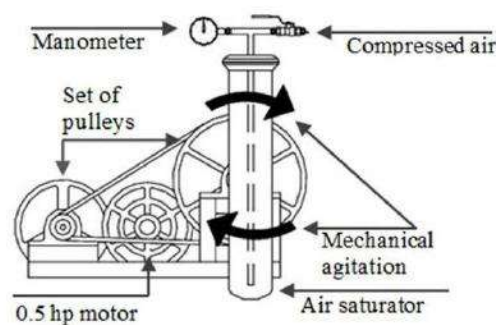
This study aimed to evaluate the influence of operating temperature and dosage of cationic surfactant for clarifying sugar syrup at 66°Brix (g soluble solids/100 g) by dissolved air flotation (DAF) process.

2. Material and Methods

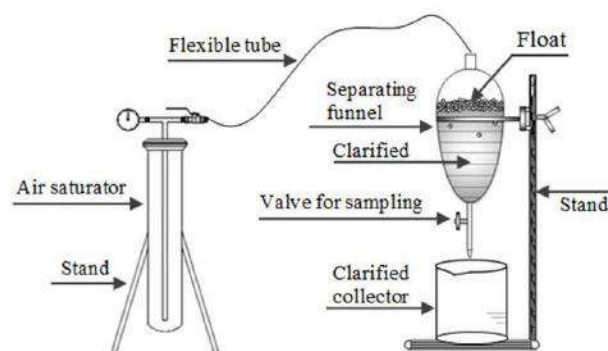
2.1. Flotation Apparatus (Air Saturator)

The DAF experiments were conducted in an air saturator bench scale apparatus constructed of stainless steel, consisting of 3 in diameter and 0.45 m height a vertical cylinder, with a total volume of 2 L, capable of treating 1 L of liquid per batch. In this cylinder is attached a cover and a vertical $\frac{1}{2}$ in diameter filtered pressed air stainless steel tube for on pressed air injection (Fig. 1).

Fig. 1: Scheme of the flotation apparatus: (a) air saturator coupled to mechanical agitator, with the movement indicating arrow; (b) flotation system coupled to the phase separation setup.



(a)



(b)

Source: Authors.

The system has a sealing lid with a pressure gauge and a $\frac{1}{4}$ " valve for the connection with compressed air and subsequent removal of liquid saturated with air after pressurization. The whole system is driven by a 0.5 hp motor, providing about 100 rpm translational agitation (Fig. 1a). For phase separation, a pear-type separation funnel was used, made of Pyrex® glass, 1000 mL

capacity and a bottom valve, which allows easy removal of aliquots for collecting the clarified product (Fig. 1b).

2.2. Crude Crystal Sugar

Samples of crude crystal sugar cane from 2010/2011 harvest, was provided by Guarani Sugar Mill plant (Cruz Alta unit), located in Olympia, state of São Paulo. This crystal sugar is called by the industry as a feedstock for the refinery, with 99.7% polarization, produced from cane juice.

2.3. Cationic Surfactant

The cationic surfactant Flonex SI 7080 (SNF Floerger, Skills Chemical, Dois Córregos, SP, Brazil) was used for neutralization and coagulation of particles (soluble, insoluble and colloidal) negatively charged present in the sugar syrup, consisting of an aqueous solution of the cationic surfactant of low molecular weight and high viscosity, containing polyamine as the active substance.

2.4. Preparation Of The Sugar Syrup

For the preparation, crude crystal sugar was dissolved in deionized water, pre-heated at 40°C, in a thermostat bath (Marconi MA-184, Piracicaba, SP, Brazil), under agitation of 1700 rpm by a mechanical stirrer (Quimis Q235, Diadema, SP, Brazil), until all sugar present was completely dissolved, forming a viscous and homogeneous syrup, with a concentration of 66 ±1°Brix and pH 5.8 ±0.2. After complete dissolution of the sugar, the temperature of the syrup was adjusted to the temperature of the experiment, and the sugar concentration adjusted with a digital refractometer (Atago PAL-3, Ribeirão Preto, SP, Brazil). The pH and temperature were measured directly by a digital pH meter and digital thermometer respectively (Tecnal TEC-11, Piracicaba, SP, Brazil).

The physicochemical analyzes were performed for each sugar syrup, prepared at the time of the experiments for clarification by DAF, to preserve its physical and chemical characteristics. The physicochemical characteristics of the sugar syrup are presented on Table 1, as average of the results of all solutions prepared for the experiments, based on the following parameters: soluble solids content (°Brix), color ICUMSA (International Commission for Uniform Methods of Sugar Analysis), turbidity NTU (Nephelometric turbidity units), conductivity and filterability.

Table 1: Physicochemical characteristics of the sugar syrup at 66°Brix.

Parameter	Value
Soluble solids content [°Brix]	66 ±1
Color ICUMSA [UI]	428 ±20
Turbidity [NTU]	5,00 ±1,00
Conductivity [%]	7,13x10 ⁻³ ±0,01x10 ⁻³
Filterability [(mL) (min ⁻¹)]	5,5 ±0,5

Source: Authors.

2.5. Air Dissolved Flotation (DAF) Experiments

For the clarification of sugar syrup (66 °Brix) by the DAF process, with cationic surfactant, the experiments were conducted based on a experimental design, using a 2³ factorial design, for two factors (temperature and dosage of cationic surfactant) with three levels each (Table 2).

Table 2: Factorial design for the DAF experiments.

Experiment	Temperature (°C)	Surfactant (ppm)	Randomized order
1		150	6
2	26	225	9
3		300	2
4		150	7
5	40	225	4
6		300	1
7		150	8
8	55	225	3
9		300	5

Source: Authors.

The controlled variables were temperature (26, 40 and 55°C) and the dosage of cationic surfactant (150, 225 and 300 ±5 ppm). The DAF experiments were randomized to minimize experimental errors. The response variable was the clarification of sugar syrup, comparing the results obtained by physicochemical analyzes of the untreated syrup with the syrup clarified by DAF process. The operating temperature was kept constant by the use of an ultra-thermostatic bath (Marconi MA-184, Piracicaba, SP, Brazil) at the temperature of each experiment until the time of transfer of the treated syrup to the flotation apparatus.

To perform the DAF experiments, the syrup dosed with the cationic surfactant was gently stirred by a glass rod, transferred to the flotation apparatus, sealed, and

subjected to the process at 895 kPa pressure. After reaching the desired pressure, the flotation apparatus is coupled to a mechanical agitator for 300 s, promoting turbulence and homogenization of the sample with injected air. Then the flotation apparatus is placed in a holder, the valve opened slowly for depressurization and transferring the biphasic mixture (syrup + micro bubbles of air) to a separating funnel, followed by the process of phase separation (clarified solution and floating agglomerates) for 2 hours. After completion of phase separation, aliquots of the clarified sugar syrup were collected from the bottom of the separating funnel, for the evaluation of the physical and chemical parameters.

The operating pressure of 895 kPa and time of 300 s for mechanical agitation were determined in a previous work (CREMA, DARROS-BARBOSA, 2011), conditions in which the concentration of dissolved air is maximum. It was observed that the earliest settling of floated particles occurs two hours after the beginning of the phase separation process.

The operating temperatures (26 to 55°C) and dosage range of the cationic surfactant (150 to 300 ppm) were determined in previous studies, in which it was demonstrated that it was possible for color removal for the clarification of sugar syrup by DAF process, using only the cationic surfactant, without adding any other chemical agent. The study also showed that there is loss of efficiency of the DAF conducted at higher temperatures (> 80°C), as is currently used in Brazilian sugarcane mills and refineries, thus, recommending flotation at temperatures below 60°C. On the other hand, inadequate temperature (too low) may negatively influence the dispersion of the fining agents used during the clarification process, delaying coagulation and precipitation of particles responsible for the color and turbidity development in the syrup, and consequently becoming difficult the separation from the liquid medium.

2.6. Analytical Methods

The analytical methodology used for assessing the DAF for clarification of sugar syrup was based on the methods recommended by ICUMSA (2007) and Copersucar (2005, 2009, 2011), by sugar industries currently used. The parameters analyzed were conductivity ash (% by weight), ICUMSA color (UI), turbidity (NTU) and filterability [(mL) (min⁻¹)].

The method CTC-MT1-LA-006, version 02/2009, using a digital conductivity meter (Analion Q279P, Ribeirão Preto, SP, Brazil), was used for the analyzes of conductivity ash. The color was determined by the ICUMSA method CTC-MT1-LA-007, version 05/2011

(GS2 / 3-9 (2005), using a digital spectrophotometer (Micronal B342II, São Paulo, Brazil) by the absorbance at wavelength 420 nm. For the analyzes of turbidity, the method CTC-MT1-LA-014 was employed, version 05/2011, using a digital turbidimeter (Quimis Q279P, Diadema, São Paulo, Brazil). The filterability was evaluated using MT1-CTC-LA-016 method, version 02/2009, by a vacuum filtration assembly.

The efficiency of flotation (ε (%)) for the physicochemical parameters of conductivity ash, color and turbidity was determined as a function of temperature and dosage of cationic surfactant, relating the initial value (untreated syrup) to the measurement of the clarified sugar syrup, by Equation (1).

$$\varepsilon(\%) = \left(\frac{C_{treated}}{C_{untreated}} - 1 \right) 100 \quad (1)$$

where ε (%) is the flotation efficiency, related to the physicochemical parameter analyzed; $C_{untreated}$ is the value of the physicochemical parameter for the untreated syrup, calculated for conductivity ash (% by weight), ICUMSA color (UI), and turbidity (NTU); $C_{treated}$ is the value of the physicochemical parameter for the clarified sugar syrup by the DAF.

For the evaluation of the results of filterability, it should be observed that the higher the rate of filterability ((mL) (min⁻¹)), better the clarification of the sugar syrup by DAF, contrary to the other parameters, which in turn they are expected to be reduced after clarification. Thus, Equation (2) was used to calculate the efficiency (%) for the parameter filterability.

$$\varepsilon(\%) = \left(\frac{C_{untreated}}{C_{treated}} \right) 100 \quad (2)$$

where $C_{untreated}$ and $C_{treated}$ are, respectively, the initial value of the rate of filterability ((mL) (min⁻¹)) for the untreated syrup and that of the clarified-treated sugar syrup by DAF.

2.7. Statistical Analysis

Assays were performed in triplicate and the results were analyzed for two factors (temperature and dosage of cationic surfactant) and three levels by the analysis of variance (ANOVA), through F-test and the averages compared by Tukey test at 95% probability, using the

software statistic Minitab 15 (Minitab Inc., State College PA).

3. Results and Discussion

Tables 3 and 4 show the flotation efficiency (%) as well as the corresponding statistical results of the respective for the physicochemical parameters of the sugar syrup clarified by DAF as a function of

temperature and dosage of the cationic surfactant, calculated by Equations (1) and (2). Fig. 2, 3, 4 and 5 show the results obtained, respectively, for conductivity ash, ICUMSA color, turbidity and filterability, as a function of temperature and dosage of the cationic surfactant the clarified sugar syrup obtained by the DAF process. For comparison, these graphs shows the value for the untreated sugar syrup (0 ppm of cationic surfactant).

Table 3: Results of the statistical analysis for physical and chemical parameters of the clarified sugar syrup by DAF as a function of temperature and dosage of cationic surfactant.

Variable	Conductivity ash	Color ICUMSA	Turbidity	Filterability
	p-value			
Dosage of cationic surfactante	< 0,000*	0.123	< 0.000*	< 0.000*
Temperature	0,009*	0.170	< 0.000*	0.018*
Interaction Dosage/Temperature	< 0,000*	0.070	< 0.000*	0.460

* Significant effect (p < 0.05).

Source: Authors.

Table 4: Efficiency of clarification (%) with respect to the physicochemical parameters of conductivity ash, color, turbidity and filterability of the clarified sugar syrup as a function of temperature and the dosage of cationic surfactant.

Temperature [°C] → Surfactant Dosage [ppm] ↓	Conductivity ash			Color ICUMSA			Turbidity			Filterability		
	ε (%)			ε (%)			ε (%)			ε (%)		
	26	40	55	26	40	55	26	40	55	26	40	55
150	22 ^c ±2	21 ^c ±2	22 ^c ±2	-28±8	-32±4	-29±6	-36 ^c ±0	-44 ^c ±1	-23 ^c ±1	64 ^a ±3	65 ^a ±1	67 ^a ±2
225	34 ^b ±1	32 ^b ±2	28 ^b ±2	-23±6	-36±6	-32±2	-77 ^b ±0	-98 ^a ±0	-98 ^a ±0	48 ^b ±2	50 ^b ±1	51 ^b ±2
300	39 ^a ±2	39 ^a ±2	42 ^a ±2	-28±1	-24±6	-25±9	-99 ^a ±0	-80 ^b ±1	-72 ^b ±0	31 ^c ±1	30 ^c ±1	32 ^c ±1

± Efficiency preceded by a negative sign (-) indicates a reduction of the parameter compared to the untreated sample, and without any sign indicates that there was an increase of the parameter analyzed.

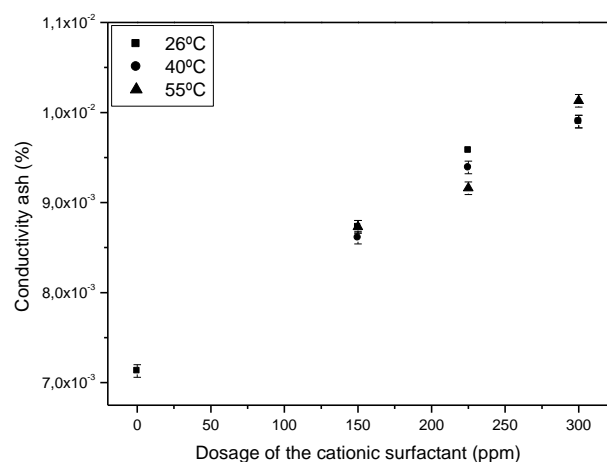
^{a,b}: Efficiency followed by the same letter, vertically, do not differ statistically by the Tukey test, at 5% confidence level.

Source: Authors.

The experimental results of conductivity ash (Fig. 2 and Tables 3 and 4) showed an increase at all temperatures and dosages of cationic surfactant. Albuquerque (2009) observed that higher temperatures could favor the removal of the ash content of the clarified sugar syrup, since heating benefits precipitation of significant amounts of certain compounds responsible for the increase in the ash contents, due to the lower solubility at elevated

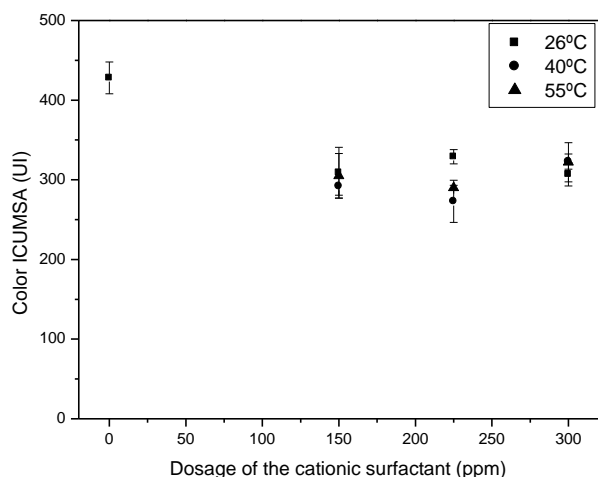
temperatures. In the temperature range used in this study, such removal was not observed. The lowest results of ash content for the clarified sugar syrups by DAF were observed at 150 ppm dosage in the three temperatures investigated. Statistical analysis for the results of ash content showed significant differences (p<0.05) at all temperatures (26, 40 and 55°C) and for all cationic surfactant dosages evaluated (150, 225 and 300 ppm).

Fig. 2: Conductivity ash of the clarified sugar syrup as a function of temperature and dosage of the cationic surfactant.



Source: Authors.

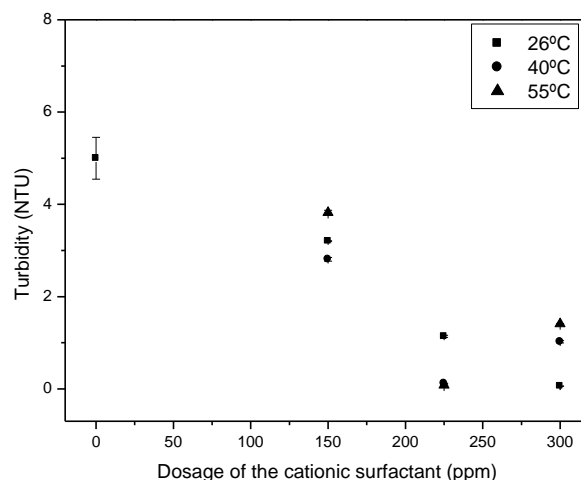
Fig. 3: Color ICUMSA of the clarified sugar syrup as a function of temperature and dosage of the cationic surfactant.



Source: Authors.

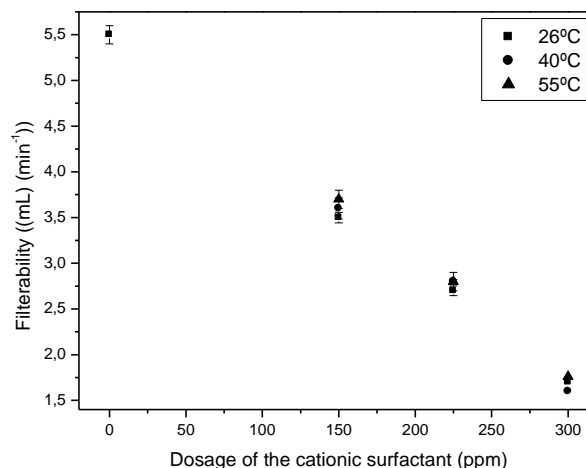
It can be noticed at all dosages of the cationic surfactant used in the experiments, that there was color removal (Fig. 3 and Tables 3 and 4) compared to the untreated syrup (0 ppm), at least with 23% color removal (225 ppm, 26°C) and a maximum of 36% color removal (225 ppm, 40°C). The most favorable temperatures for the removal of color were 40 and 55°C. Thus, it can be inferred that the best outcome for the color of the clarified sugar syrup obtained by the DAF process, compared to the untreated samples, was at a dosage of 225 ppm and temperature of 40°C. The temperature and dosage of cationic surfactant showed no significant differences ($p > 0.05$) for the results of color of the clarified sugar syrup by DAF.

Fig. 4: Turbidity of the clarified sugar syrup as a function of temperature and dosage of the cationic surfactant.



Source: Authors.

Fig. 5: Filterability of clarified sugar syrup as a function of temperature and dosage of the cationic surfactant.



Source: Authors.

The experimental results for the turbidity of the clarified sugar syrup (Figure 4 and Tables 3 and 4) show that at all temperatures and at dosages of 225 and 300 ppm of cationic surfactant there was a great reduction in turbidity as compared to the untreated syrup. The best results were obtained at 26°C and 300 ppm of the cationic surfactant, and at temperatures of 40 and 55°C and 225 ppm of the cationic surfactant showing 98% reduction or greater in turbidity of the clarified sugar syrup compared to the untreated syrup. Such combinations of treatments provided clear sugar syrups, indicating the removal of dispersed colloids in the syrup by the DAF process. The range of temperature (26-55°C) and dosages of cationic surfactant (150-300 ppm) investigated as well as the interaction between them has significantly influenced positively the turbidity ($p > 0.05$),

in a way that higher temperatures implies lower dosage of cationic surfactant to obtain a clear syrup.

Fig. 5 and Tables 3 and 4 show that a higher dosage of the cationic surfactant has negatively influenced on filterability of the clarified sugar syrup compared to the untreated syrup. Note that an increase in the filterability implies in better performance (positive $\varepsilon(\%)$) of the clarified treated syrup, differently from the other physicochemical parameters. This fact could be observed at the lowest dosage (150 ppm) at all temperatures investigated (26, 40 and 55°C), in which a greater volume of filtrate in relation to other dosages was obtained, indicating that there was a significant removal of undesirable high molecular weight substances in the clarified sugar syrup by the DAF process such as starch and dextran. Statistical analysis indicated a significant ($p < 0.05$) effect of temperature and dosage of the cationic surfactant on filterability of the clarified sugar syrup.

Although higher dosages of cationic surfactant reduced the rate of filterability, there is a favorable behavior in respect to the temperature, to which we can conclude that the higher the operating temperature the greater the rate of filterability (Figure 5 and Table 3). These results suggest that at higher temperatures, precipitation and removal of unwanted substances present in the syrup is favored, and therefore increasing the DAF process efficiency, even though higher temperatures does not favor the dissolution of air into the liquid medium.

It is interesting to note that the higher the ash content in the clarified sugar syrup the lower the filterability. This fact can be confirmed by the analysis of conductivity ash (Fig. 2), for which the best combination treatment was obtained in the same dosage (150 ppm) and at all temperatures (26, 40 and 55°C) for filterability (Fig. 5). So, the best combination of dosage and temperature, which yielded better results for the filterability of clarified sugar syrup was obtained at 150 ppm of cationic surfactant at temperature of 55°C with an 67% increase in performance for this parameter.

In general, it was observed for the three temperatures (26, 40 and 55°C) and dosages of cationic surfactant (150, 225 and 300 ppm) investigated in this study, 225 ppm of cationic surfactant and 40°C, presented the best results, with the highest removal of color (36%) and turbidity (98%). This same dosage and temperature, the result of filterability rate (50%) presented a satisfactory value, but with an increase in ash content (32%) due to the contribution of the ions present in the cationic surfactant added to the sugar syrup, which were not fully removed by the DAF process.

In study Crema-Cruz et al. (2016) using the same dosages of cationic surfactant at 26°C, applied to another lot of crude sugar crystals (color 355 UI, turbidity 6,00 NTU, conductivity ash 11,0 $\cdot 10^{-3}$ % and filterability 6,1 mL min⁻¹) from a different sugar mill, for evaluation of clarification of the sugar syrup by the DAF process, similar color removal, but different results for turbidity and ash from those obtained in the present study, showing the great influence of the raw material used, indicating a need to supplement the DAF process by vacuum filtration or other supplementary technique. According to Spencer and Meade (1967), small differences in total ash content before and after clarification of sugar cane juice may be attributed to changes in the chemical composition and to the addition of auxiliary clarifying agents (eg. calcium hydroxide and phosphoric acid) for the coagulation and precipitation of particles.

Thus, it can be suggested that, for each raw material used in a refinery, chemical treatment given for the coagulation and precipitation of particles to promote the clarification of sugar syrup should be specified according to the quality and composition of the raw material used, and the DAF process may be complemented by filtration to remove ash, in other subsequent stages of production.

4. Conclusions

Whichever the temperature, the greater the dose of cationic surfactant, the higher the values of ash contents of the clarified sugar syrup. The dosage of cationic surfactant of 225 ppm at 40°C, yielded better results, with the lightest color (36% removal), highest turbidity removal (98%), and highest rate of filterability (50%), but with an increase in ash content (32%). To help in the removal of ash, the process should be complemented by filtration, or using raw material (crude sugar crystals) with higher quality, facilitating the refinement of crystals and reducing the production cost. The study has demonstrated that it is possible to remove color and turbidity, and to increase in rate of filterability for the clarification of sugar syrup by DAF process by using only the cationic surfactant without adding any other chemical agent, and conducting the process at relatively low temperatures, thus at reduced operational costs.

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6. References

- [1] ALBUQUERQUE, F. M. **Processo de fabricação do açúcar**. Recife: Ed. UFPE, 2009. 275p.
- [2] CHOU, C. C. **Handbook of Sugar Refining: A manual for the design and operations of sugar refining facilities**. New York: J. Wiley, 2000. 756 p.
- [3] COOPERATIVA DE PRODUTORES DE CANA-DE-AÇÚCAR, AÇÚCAR E ÁLCOOL DO ESTADO DE SÃO PAULO (COPERSUCAR). **Clarificação**. São Paulo, [199-?]. 58 p.
- [4] COOPERATIVA DE PRODUTORES DE CANA-DE-AÇÚCAR, AÇÚCAR E ÁLCOOL DO ESTADO DE SÃO PAULO (COPERSUCAR). **Métodos de análise em açúcar, álcool e processos**. Piracicaba: Centro de Tecnologia Copersucar, 2005. n. p.
- [5] COOPERATIVA DE PRODUTORES DE CANA-DE-AÇÚCAR, AÇÚCAR E ÁLCOOL DO ESTADO DE SÃO PAULO (COPERSUCAR). **Métodos de análise em açúcar, álcool e processos**. Piracicaba: Centro de Tecnologia Copersucar, 2, 2009. n. p.
- [6] COOPERATIVA DE PRODUTORES DE CANA-DE-AÇÚCAR, AÇÚCAR E ÁLCOOL DO ESTADO DE SÃO PAULO (COPERSUCAR). **Métodos de análise em açúcar, álcool e processos**. Piracicaba: Centro de Tecnologia Copersucar, 5, 2011. n. p.
- [7] CREMA, L. C. **Clarificação por flotação com ar dissolvido (FAD) da calda de açúcar cristal para produção de açúcar refinado**. 2012. 128 f. Dissertação (Mestrado em Engenharia e Ciências de Alimentos) – Instituto de Biociências, Letras e Ciências Exatas, Universidade Estadual Paulista, São José do Rio Preto, 2012.
- [8] CREMA, L. C., DARROS-BARBOSA, R. **Pressure and mechanical agitation influence on air absorption in the flotation process for the sugar cane syrup clarification**. In: VIII CONGRESO IBEROAMERICANO DE INGENIERIA DE ALIMENTOS, 8, Lima, Peru. Anais... Lima, Peru: CIBIA, 2011. p.1-6.
- [9] CREMA-CRUZ, L. C. **Clarificação da calda de açúcar por flotação com ar dissolvido e caracterização das microbolhas, partículas e aglomerados formados**. 2017. 197 f. Tese (Doutorado em Engenharia e Ciências de Alimentos) – Instituto de Biociências, Letras e Ciências Exatas, Universidade Estadual Paulista, São José do Rio Preto, 2017.
- [10] CREMA-CRUZ, L. C.; HUBEL Michele; DARROS-BARBOSA, Roger. **Clarificação da calda de açúcar por processo de Flotação com Ar Dissolvido (FAD) auxiliado por surfactante catiônico**. In: XXI CONGRESSO BRASILEIRO DE ENGENHARIA QUÍMICA, Fortaleza, CE. Anais... Fortaleza, CE: COBEQ, 2016. p.1-8.
- [11] DOHERTY, W. O. S.; EDYE, L. A. An overview on the chemistry of clarification of cane sugar juice. **Proc. Aust. Soc. Sugar Cane Technol.**, Mackay, 21, 381–388, 1999.
- [12] HOLMBERG, K. et al. **Handbook of Applied Colloid & Surface Chemistry**. New York: J. Wiley, 2002.
- [13] INTERNATIONAL COMMISSION FOR UNIFORM METHODS OF SUGAR ANALYSIS (ICUMSA). **Methods Book.Germany**: Bartens, 2011. 128 p.
- [14] JENKINS, G. H. **Introduction to cane sugar technology**. Amsterdam: Elsevier, 1966. 478 p.
- [15] RIBEIRO, P. R. **A usina de açúcar e sua automação**. Araçatuba: SMAR - Divisão Açúcar e Álcool, 2, 2003. 151 p
- [16] REIN, P. **Cane Sugar Engineering**. Berlin: Bartens, 2007. 768 p.
- [17] REIN, P. **Engenharia do Açúcar de Cana**. Tradução César Miranda e Ericson Marino. Berlin: Bartens, 2013. 872 p.
- [18] RICHTER, C. A. **Água: métodos e tecnologia de tratamento**. São Paulo: Edgard Blucher, 2009. 352 p.
- [19] SPENCER, G. L., MEADE, G. P. **Manual del azúcar de caña: para fabricantes de azúcar de caña y químicos especializados** (Tradução Mario G. Menocal. Barcelona: Montaner & Simon, 1967. 940 p.

Application of the Lean Manufacturing Culture: Case Study in a Cell Phone Company of the Industrial Pole of Manaus

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Abstract— *The productive potential of the industries, the increasing need for effective industrial process management and the opportunity for general improvement of corporate performance, through the application of the concept and tools of Lean Manufacturing, were the main motivating agents of this research work. In the context of this scenario, the cellular manufacturing processes were analyzed in a manufacturing company outsourced from the Industrial Pole of Manaus that uses the literature of Lean Manufacturing as a pillar of support to confection of its functional processes. The case study was structured in three distinct parts: analysis of the original situation of the company, identifying opportunities for improvement according to the specificities of the process flow; application of the identified improvements and finally a comparative analysis between the data obtained with the improvements on the processes with respect to the wastes identified.*

Keywords— *Lean Manufacturing, Value Stream, Productivity.*

I. INTRODUCTION

The implementation and significance of Lean Manufacturing in industry is confused with the history of the industrial revolution itself. In this process, History reveals that success is not only evidenced by the speed of production, but by the effectiveness of productive methods and the reduction of expenses.

With globalization underway, the global market has become violently competitive, requiring cost reduction and better levels of productivity. Equity: Survival has become the big challenge organizations, which, coupled with competitiveness and technological advancement on several fronts, has emerged new organizational techniques, which seek to keep organizations in a floating state, developing administrative systems more efficiently agile and strong enough to the standards established by the mutant need of society, thus avoiding a series of wastes, including time.

Even if you started in the automotive industry, the philosophy of Lean Manufacturing is used in a variety of activities, from raw materials to distribution services and others.

In outsourced assembly companies, the uncontrolled and arithmic production means loss of inputs and time, and with the increasing demand for production, the need for faster and more efficient methods of production arises,

and, in order to deal with more efficient and fast methods of producing on a large scale, even though it is considered the most effective way in terms of sustainability and economic viability, it is a process that faces many challenges, such as the difficulty in the process planning process, productive organization and the offer of quality products, once that the acceleration of the process should not occur to the detriment of the loss of quality in production.

In this context, the present work aims to verify if the tools of Lean Manufacturing can contribute positively to the assembly process of cellular devices, using numerical data regarding the production of units per hour (UPH) and the collection of information on the main factors negatives that contribute to low productivity, thus enabling the development of effective solutions that can mitigate the negative factors of production, using information such as: production time per unit, provision of inputs in the process line, quantity of defective products and final products assembled per hour of production.

II. THEORETICAL FOUNDATION

As long as technological evolution does not mitigate the need for human intervention in production processes, companies that have the assembly process, whether

outsourced or not, will have challenges of agility and quality in industrial production, whether linked to the layout of the production line, agility in the exchange of information between the line and the warehouse, where the speed of production and the quantity of pieces produced per hour is a reflection of the quality in the process flow, which potentiates the added value of the final product.

Outsourced assembly companies have a system where distinct brand products are manufactured in differentiated lines, which are operated by teams unique to that process. The interval between receipt of inputs, their layout in the available layout on the production line and the delivery of the final product generates a lead time, which, depending on the size, does not add value to the product and can generate losses to the company.

2.1 Lean Manufacturing

The Lean Production System is a set of actions that aims to increase the capacity to respond to changes and mitigate waste in the productive flow, creating a transformative management organization.

In his work [1], he postulates that this system has as principles: keeping the right items in the right places, right mind and the right quantity; create and nurture effective relationships within the Value Chain; working towards Continuous Improvement in search of quality in the first unit delivered.

Regarding the identification of waste, the key point is to reach a level where the production capacity is equal to the one requested by the final customer.

This means that in the companies there are human, material, technological process flows to produce exact quantity of the service or product that was requested, all with timely delivery of the final product [2].

When this balance between capacity and load does not occur, the synthesis of these occurrences is an impediment to the company, that is, it generates waste. Taiichi Ohno (1912-1997), Toyota executive and great critic of procedural waste - identified the seven types of production waste:

2.1.1 Excess production waste:

Producing the unnecessary, taking time to prepare the necessary machinery, as well as the distances to be covered with the inputs, and the lack of coordination between different procedural sectors, inevitably leads to problems and constraints in the production process.

2.1.2 Waiting waste:

According to the Lean philosophy [3], the movement of machines is not mandatory at all times, but human productivity can not wait. The accumulation of inputs

caused by the lack of material flow management and the flow of information form queues that tend to overload the use of equipment. In this sense, the Lean reaffirms the management of this flow of materials with the objective of maintaining and enhancing the flow of human production.

2.1.3 Transport and handling waste:

As indispensable activities for the production process, the flow of people and materials takes time, since the procedural limitations of production require a displacement perpendicular to the dimensions of the facilities, materials and stages of production. To reduce this movement to the maximum, either with procedural or physical changes in the installations is one of the points defended by the Lean philosophy [4].

2.1.4 Waste of the process itself:

According to [5], the production process has steps that do not always add value to the final product. How, where and why to produce are important questions at the moment of procedural management. The Lean philosophy puts in question any process that can add cost and not values to production.

2.1.5 Unnecessary waste of work:

In his work [5] he states that when a movement / process is very fast, slow or obsolete, there is no economy or a consistent approach to the processes, so if a company decides to automate such processes without the knowledge of the real needs of production, there is the risk of automating waste.

2.1.6 Waste of defective products:

Defects imply directly the waste of materials, human production flow, use of equipment besides the unnecessary storage of these poorly used inputs, problems directly linked to quality. An innovative approach to the production process that minimizes the occurrence of defects makes it possible to remanue inspection processes [1].

2.1.7 Waste storage

In its article [6] it points out "Towards Lean Product Lifecycle Management: the Framework for New Product Development", that the use of stocks in the traditional production aims to avoid productive arithmia, however this system hides quality problems by generating productive islands, the process flow, increases the occurrence of setup problems, besides causing an unnecessary occupation of the physical space that could be better used in the productive process, since there is bureaucratic and human displacement due to its existence.

2.2. Lean Manufacturing as Productive Philosophy

The concept of Lean Manufacturing is based on the naming of waste and elements that do not add value in

order to reduce costs, producing defect-free goods in the shortest possible time using the least amount of equipment and labor, aiming at customer satisfaction and productivity. making it more competitive [7]. In general, the Lean system is defined as the western reading of the Japanese production model, especially the Toyota Production System (TPS).

The book "The Machine That Changed the World" by Womack (1990) popularized the Lean definition, which, in short, sought to explain the Lean system with the idea of using half human workflow, manufacturing space, investment in tools and in time in engineering, with the goal of producing a new product. As a philosophy, Lean is a specification mode that aims at enabling actions that add value while reducing costs, performing these activities uninterruptedly when they are requested and performing them every time more efficient.

In his work [8] the management literature suggests that contextual factors may present strong forces within organizations that inhibit implementations that seem technically rational. [9] addresses the benefits of lean manufacturing deployment. [10] It addresses how paradigms of lean thinking and agile manufacturing have been developed, which has been a tendency to visualize them in a progression and in isolation.

Womack analyzed the many faces of implementation and development of improvements and with the influence of the Toyota production system, identified the essential causes of these implementations, which became known as the five principles of the Lean philosophy, namely: specification of value, identification of value chain and value stream, leaving the aggregate value to the end customer, since the central objective of this philosophy is the continuous search for perfection.

III. TOOLS AND METHODS

The company targeted for the installation of the project is located in the industrial pole of Manaus of the electronics industry. In order to preserve its identity and confidential data, the present work will be directed to it only as a company.

Born in the wave of outsourcing in the 1980s, she specialized in electronic components, manufacturing computers, telephones and medical equipment, as well as being responsible for the packaging and delivery of the products.

The company operates from Monday to Saturday, in three shifts of eight hours each, in addition to the business hours (financial and administrative sector) that runs from Monday to Friday. The focus of production at the Manaus

Industrial Complex is the cell phone and charger. The improvement will be applied in the cell phone line.

The first stage of assembly of the products begins in the main warehouse, where the pieces that are common to all the apparatuses like, for example, plates and structures of cellular phones used in any equipment are accumulated. From there, the products move on to the second phase.

Each brand then wins its production cell (independent units) and an exclusive team of assemblers, consisting on average of 75 people. With the flow of demand and the high complexity in materials management, the company presented a series of problems related to process management and mode of production, such as:

- Unbalanced and unbalanced production, with excessive idle time and focused operational wear.
- Loss of material from the ratio of raw material quality and asynchrony between demand and production in terms of quantity and time.
- Stock problems (warehouse): The company's warehouse had no defined pattern in relation to allocation, model identification or organization. In the case of a company that manufactures products of different brands in a product family, the differences between the models are minimal, differences that do not change its manufacturing process, but compromise its operation.

In order to understand the company's needs efficiently, quality management tools were used, including Value Stream Mapping (VSM), Ishikawa chart, Pareto chart, followed by the 5S implementation.

3.1 VSM: Value Stream Mapping

Value Stream Mapping (VSM) is a mechanism that can visually demonstrate the stages of material and information flows, while the product follows the flow of value, a helper in the perception of what value adds, from the supplier to the supplier. to the consumer. Thus, the mapping of the current state, the mapping of the future state and the mapping of what is objectified, if necessary, is developed.

This process consists in the identification of specific activities that happen during the flow of value, where value flow is the asynthesis of all the activities that happen from the request made by the customer to the delivery to the final consumer.

This is a process of understanding the production and illustration of a process map that will become the basis for Lean system deployment. In other words, represented in Figure 1, the VSM is a visual representation of the flow processes of the material and actual information synthesized into a set of key questions and with the

development of a map of the desired future state of how the production should proceed.

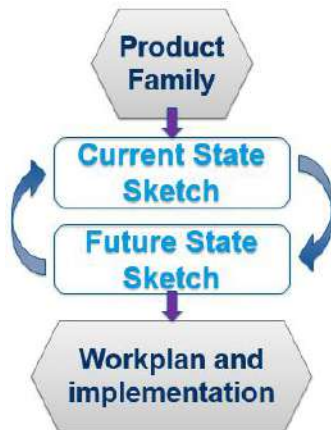


Fig. 1: Basic Mapping of Value Flow. Source: Adapted by the author

3.2 Ishikawa

The Ishikawa Diagram is a tool that enhances the graphic quality used to manage the various processes, allowing the hierarchical structuring of the motivations of a given problem and was developed with the purpose of providing a graphic view of the various causes that affect the procedural flow, by classification and relation of causes.

Besides that, it also allows the structuring of systems that need a response in a graphical and synthetic way, thus providing a detailed and holistic view on the subject studied.

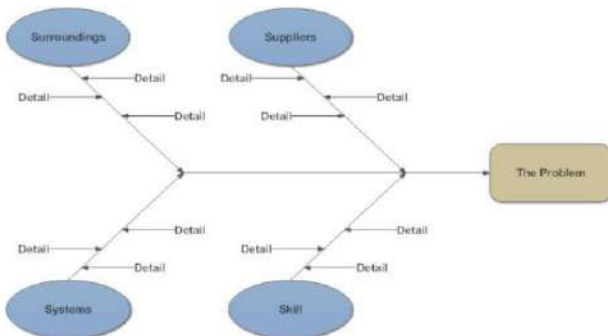


Fig. 2: Ishikawa Diagram

As can be observed in Figure 2, it is structurally composed of: head, which corresponds to the problem to be studied; scales, which correspond to the factors influencing the problem, including the subcauses, consequences and the steps to be taken for resolution. Its construction takes into account factors such as: the problem to be analyzed, possible causes for occurrence, structuring them to the left of the central problem.

3.3 Pareto Diagram

Pareto Analysis distributes a large problem in small proportions easier to solve, allowing projects to be prioritized and more concrete and tangible goals set.

The Pareto Diagram divides the problems into two classes: Few Vital and Many Trivia. So, it means to say that a problem has several causes, but only a few have a great impact or great loss.

It can be observed in Figure 3, the Pareto Diagram consists of vertical bars that represent the causes of a given problem, ordered in descending order of incidence, in addition to a line of cumulative percentages that show the causes of greater impact.



Fig. 3: Pareto Chart Scheme. Source: (ROUSE, M. 2011)

3.4 Tool 5'S

5's is a widely used tool in the implementation of the Lean concept and its main objectives are to improve the quality of products, work environment and customer service, the quality of life of employees and maximize the use of available resources, reducing waste and taking advantage of to maximize physical space, in addition to reducing and preventing accidents, improving human relations and increasing employee self-esteem.

The 5S acronym was originated from Japanese words beginning with the letter S: Seiri (Sense of Use), Seiton (Organization Sense), Seiso (Sense of Cleanliness), Seiketsu (Sense of Health and Hygiene) and Shitsuke (Sense of Discipline).

Among them, the concepts of Organization and Cleanliness are fundamental to the process of implementation of the concept of Lean production, because only in this way will it be possible to clear clear problems, satisfactory control of waste products, besides the gain of productive reliability, which comes to produce control and gain the quality of production by increasing the quality of the processes and the working conditions in which the employees will be inserted.

IV. LEAN MANUFACTURING IMPLEMENTATION

The implementation of the project was initiated through a technical analysis in the cellular line with the purpose of knowing the process and collecting the necessary data for conclusion of the study. With this purpose were used as sources of information: the records, Kaizen event and direct observation in the production line where the cell line needed to produce 340 cell phone per hour to meet the customer and the current hour production was in 289 cell .

After a first low productivity analysis, the company team was assembled to outline the nature and dimensions of the causes of the problem, in this case the low productivity in the cell phone line.

A Kaizen event was held to better understand the production flow and identify opportunities for improvement, minimizing waste and gaining productivity. A questionnaire was also distributed to operators where they could expose their greatest difficulties.

On the second day, based on information obtained locally, the graphical versions of the Value Stream, Ishikawa Diagram were constructed, where the causes of the production problem were instated and the Pareto Diagram was constructed, where all negative points and difficulties encountered by presenting the current state.

4.1 Analysis of the data

Analyzes of the implementation data were performed, which will be presented below, in the topics VSM analysis, application of Ishikawa, use of data in Pareto diagram, implementation planning and execution.

4.1.1 VSM Analysis

Based on the technical analysis a map was developed of the value stream of the cell line and the following information was verified: There are eight workstations in the process called the bottom phase (where all the components of the bottom of the circuit board are assembled printed) and according to the flow of this process it was identified that in the first station there was excess of stopped material to enter the line.

In the process called top phase (where all the components of the printed circuit board are assembled, with 10 workstations), it was identified in the first position that there was an excess of material stopped, and that in the last station the excess of material was much larger, causing the whole line to stop.

In this position the machine responsible for cutting the boards (Router machine), was intermittent stop with several false failures, the operator was busy with activities, there was no standardization of work, the layout was not adequate, there was no maintenance plan

for the equipment. In Figure 4, the construction of the VSM is presented.

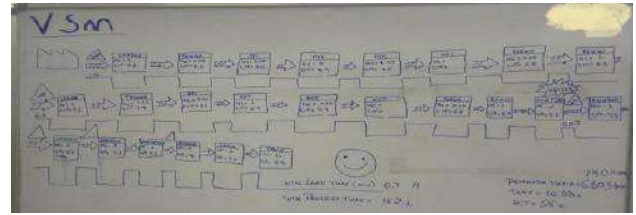


Fig. 4: Development of VSM

In the next process, where the assembly was done, there was a lot of excess material stopped in the process.

4.1.2 Application of Ishikawa

After analyzing the value flow, a Pareto diagram was constructed with the causes of low productivity in the cell line. Among the causes identified were:

- High temperature: The production area was in an environment that presented excess heat causing fatigue to employees, stopping machines for false failures.
- Operator without training: There was no standard operation or standardization documents were not in line with the reality of the process, causing meontage delay, assembly defect or even parts scrap.
- Incorrect Flow: There was no clarity in the flow of this process.
- Failures in the AOI: SMD component inspection machine responsible for identifying if there was a wrong assembly, for example, if the resistor was not mounted in the capacitor position, if the components were correctly assembled without displacements, it had excessive faults.
- Test Failure: Responsible testing to check the circuitry of the phone's circuit board was exhibiting false failures from the external heat of the environment.
- Router: Router machine responsible for separating the cell phone boards from the matrix through cuts according to program that model asked was presented exose from false failures, machine was breaking frequently.
- Output of botton pieces: Production of the bottom phase was not attending the top phase.

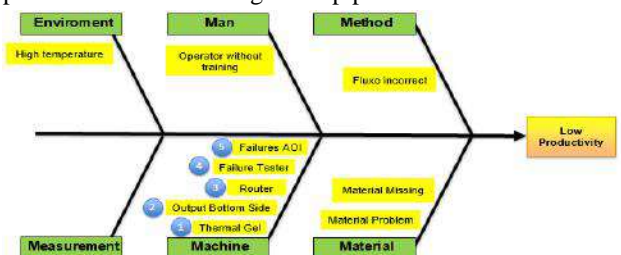


Fig. 5: Ishikawa diagram with visualization of causes

- Thermal gel: Process of applying the thermal gel on the cell plates was causing excess defects, machine was intermittent failure.

- Loss of Material: Material misallocated, were not obeying the fifo (first that enters is the first one that leaves).

- Material Problems: Material delivered by the external supplier was presented with many defects.

4.1.3 Using the Data in a Pareto Diagram

After analyzing the Ishikawa plot, we extracted the information from the Pareto process, where it was possible to identify the main villains that were directly impacting the low productivity of the cell line, confining past insomings of the responsible areas such as quality, productivity, pcp.

As shown in Figure 6, each problem was analyzed and each team member was responsible for each action to be taken to solve each identified problem.

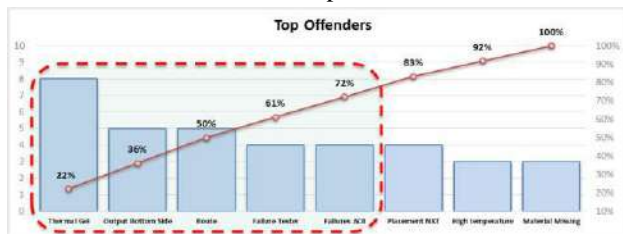


Fig. 6: Pareto diagram with data obtained

The main villains shown in the pareto were: Frequent breaking machine, where the application method was not meeting the quality plan; layout was not clear; process of the bottom production phase was not meeting the top production process due to a series of defects in the process and machine stops; router machine breaking frequently, there was no claresa in the operation execution process, excessive false faults due warm environment; testing machine were with excessive false failures due to warm environment, there was clarity in the process of the operating method of work.

In addition, the component inspection machine on the printed circuit board AOI was exhibiting false failures, many machine breakdowns; NXT machine responsible in the icersion of compontes in printed circuit board was with posing false faults, stopping for lack of compentes, warm environment; material from the external customer.

4.2 Implementation Planning

The cell line was with low productivity, as can be seen in Figure 7, which was marking the production of 2268 cell phones per day, while the amount requested in the customer order would be 2720 cell phones per day.

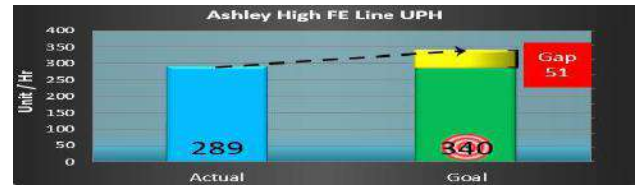


Fig. 7: Definition of target to be achieved

To achieve this goal in the three shifts, each shift would have to produce 340 cell phones per hour. With the presentation of the procedural problems in the analysis phase, some possible changes in the cellular line were visualized without the need for large investments, reaching the goal of the production value requested by the customer.

4.2 Execution

It was found that the test coverage device Jig did not close properly because the pin was worn causing intermittent failures causing downtime and productivity delays. Figure 8, After analysis in the process with the team involved, a pin with a larger thickness was used together with the moonshine section to lock the top of the cellular apparatus, after this adaptation the freeness problems were eliminated.



Fig. 8: Pin Lock

Piece of kapton tape from the components below, causing the test to fail. This problem was occurring frequently, and whenever the tests began to fail, the technician was required to stop the process for repairing the tests once the tests were filled with tape attached to the test needles.

During the analysis, it was defined that the employee who received the plates of the post-refueling process made the removal of the tape that was fixed between the

pallet and the plate of the cellular and defined maintenance plan of the palles through a control of maintenance shown in Figure 9. After the actions taken the intermittent problem that there was in the process was solved.

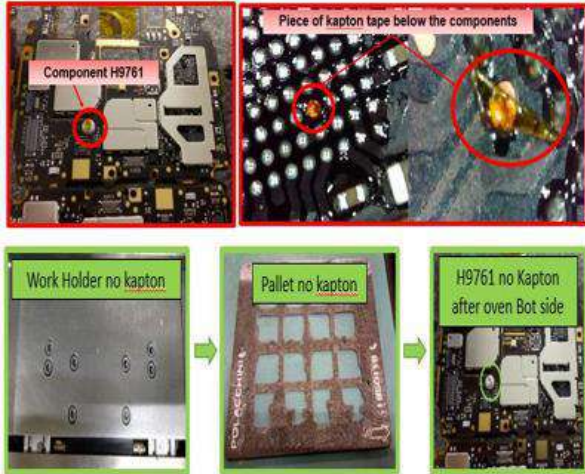


Fig. 9: Maintenance of the yards

Disorganized visual inspection station. The activities carried out by the collaborator were not clear, on the bench there were many materials that were not being used, there was excess of movement in the accomplishment of the activities. A 5S was defined in the area of visual inspection so that after the end, the activities carried out by the collaborator of this post were organized, improving the economic part and gain in the execution time of their activities, shown in Figure 10.

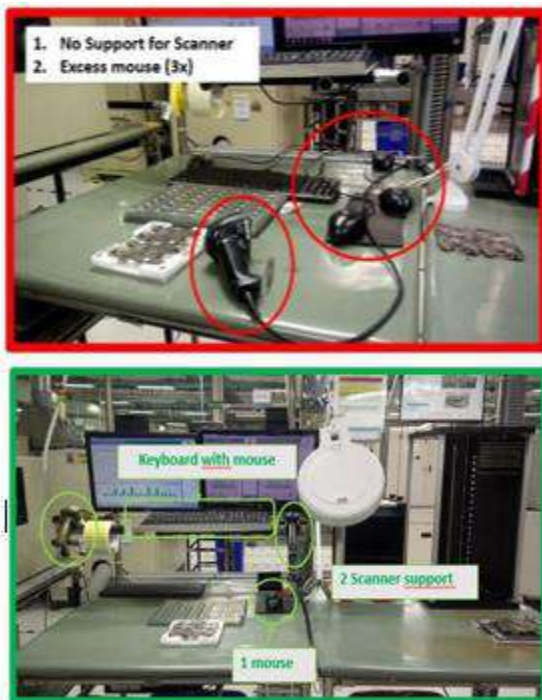


Fig. 10: Organization of 5s

There was no visual management to inform operators of quality and productivity indicators, so the process developers did not know how their production goals were and how quality of hour-and-hour production was.

Once this need was identified, a visual management framework was developed and each strategic point of the mobile phone line was installed so that all of that process had the goal information, hours produced and the number of defects in the line. This idea of implantation of visual management, Figure 11, made the actions to be taken in the process were more agile and effective.



Fig. 11: Visual management information frame

In the process of applying plate likes there was no weighing control, this lack of weighing control was causing defects. These defects were identified in the tests where the plates were failing because the amount of material applied on the plate was not as defined by the quality. In order to solve this problem, we used a feature that we already had in mind, but the only idea was to introduce this line, which was a device, shown in Figure 12, to warn the employee to check weighing after 12 plate pallets made in your process.



Fig. 12: Plate pallets

In the reflow phase in the welding furnace, which consisted in the solderability of the SMD components of the board, we were having solder defects. Adjustments were made in the weld profile and enabled the nitrogen a

feature that the reflow oven machine has. After the improvement actions in the reflow oven process, the welding failure in the plate components in the process is over.

In the post-furnace reheat phase, the plates were coming off with an excessive temperature causing false failures in the tests. After analysis with the team, it was adapted blowers / fans in magazines where the plates passed out of the furnace straight to the magazine responsible for cooling the plates. This idea not only solved the false failures in the tests but also improved the activity of the operator receiving these plates from the reflow oven.

In the test benches there was no control of pattern of faulted plaques. This form of work was generating bench reprocessing because there was no set location for the tested boards and boards that were missing to test. The solution to this problem was to make a new layout, shown in figure 13, where the dots were identified to avoid re-testing.



Fig. 13: New Layout

In the process of separation of the cellular plates carried out by the router machine through cuts, there were two operators where each one carried out its activities. After the re-layout improvements, shown in Figure 14, adapted in the process, it was possible to eliminate one station from that machine and relocate the operator to another activity in the factory, thus reducing a quand we had in the three shifts in the cell line of 78 employees for

75 employees. This change in productivity did not affect productivity.

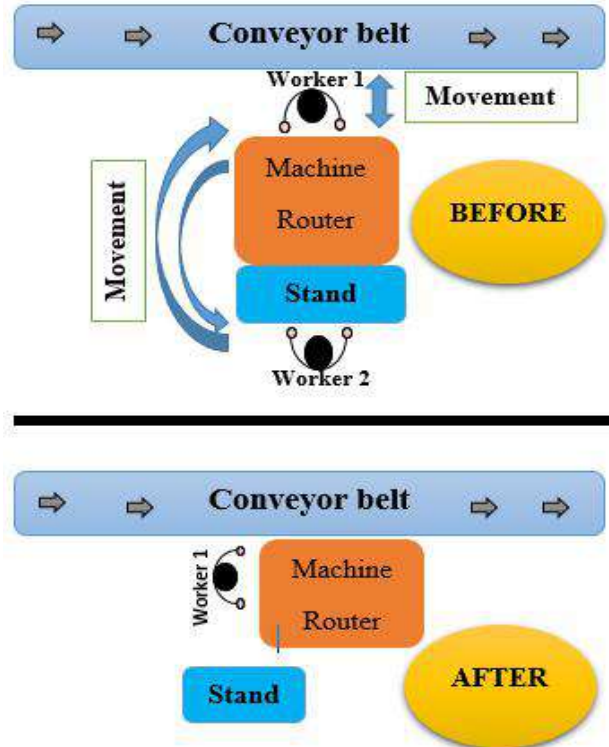


Fig. 14: before and after the implementation of the new layout

All stages of lean manufacturing implementation were performed.

V. RESULTS AND DISCUSSIONS

After all the actions performed and follow-up in the process of the implementation week, the application of the Lean and with the use of the help tools was obtained a significant improvement in the productivity of the company, as shown in figure 14. During the first two days, improvements were implemented gradually, it was verified that the productivity was still below the expected, already after the following days, the results of the implementation were achieved with good results.

C/Os	Measurement	Unit	Start	Target	Kazan Week					Actual			
					Day 1	Day 2	Day 3	Day 4	Day 5				
F	1-PCBA Productivity UPH	unit	HR	239	340	18	283	303	340	353	361	361	108
D	2-FPY	%	Day	96	90	2	98.46	98.2	98.31	98.2	97.98	97.98	99
F	3-DL	person	Person	78	75	4	75	75	75	75	75	75	100

Fig. 15: Productivity results during deployment week

However, from the implementations and structural modifications, in this case (in particular) the layout of the production line, were definitive factors for the agility of response to occurrences within the sector, shown in figure 16.

LOSS	PROBLEMS	SOLUTION	GAIN
Overproduction	Asynchrony between demand and productivity	Analysis of component production and implementation of layout	25% increase in assembly line productivity.
Wait	Lack of stock standardization (quality)	5s Tool Application	Savings of up to 5 minutes in raw material demand
	Machine Unavailability	Biweekly and weekly preventive maintenance plan	
Transport	Ineffective layout in assembly	Restructuring the layout	Average Production of 1 cell phone every 10 seconds
Process	Assembly process divided into two steps without need	Restructure activity with the router	Decrease in operational staff per shift.
Products Defective	Processing of defective products	Elaboration of discards guide	Creation of flow chart as a decision tool

Fig. 16: Analysis and proposal of solutions

Thus, it was possible to verify the productivity increase from 289 units / hour to 340 units / hour, with one operator per shift reduction, and (FPY - first pass yield) yilde increase to 2%.

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REFERENCES

- [1] SHINGO, Shigeo. O sistema Toyota de produção, do ponto de vista da engenharia da produção. Bookman. Porto Alegre, 2005.
- [2] OHNO, Taiichi. O sistema Toyota de produção além da produção. Bookman, 1997.
- [3] DAVIS, Mark M.; CHASE, Richard B.; AQUILANO, Nicholas J. Fundamentos da administração da produção. Bookman, 2001.
- [4] WERKEMA, Cristina. Lean seis sigma. Elsevier Brasil, 2011.
- [5] ANTUNES, Junico. Sistemas de produção: conceitos e práticas para projetos e gestão da produção enxuta. Bookman Editora, 2009.
- [6] HINES, P., FRANCIS, M., & FOUND, P. 2006. Towards lean product lifecycle management: a framework for new product development. Journal of Manufacturing Technology Management. London, 2013.
- [7] WILSON, Lonnie. How to implement lean manufacturing. New York: McGraw-Hill, 2010.
- [8] SHAH, Rachna; WARD, Peter T. Lean manufacturing: context, practice bundles, and performance. Journal of operations management, v. 21, n. 2, p. 129-149, 2003.
- [9] MELTON, Trish. The benefits of lean manufacturing: what lean thinking has to offer the process industries. Chemical

engineering research and design, v. 83, n. 6, p. 662-673, 2005.

- [10] NAYLOR, J. Ben; NAIM, Mohamed M.; BERRY, Danny. Leagility: integrating the lean and agile manufacturing paradigms in the total supply chain. International Journal of production economics, v. 62, n. 1-2, p. 107-118, 1999.

Implementation of an Industrial Maintenance Services Management Company in the City of Manaus - Amazonas - Brazil

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Abstract— *The services segment in recent years has, in a certain way, driven and encouraged the creation and formalization of small and medium enterprises to provide services and products. In this sense, it is necessary for the entrepreneur to understand how to implement a company that provides industrial maintenance services. In order to do so, the main steps of the business planning for the implementation of a service company in the city of Manaus - AM will be presented. In order to implement a medium or large enterprise, it is necessary to take into account the basic premises of a business plan that serves as a guiding base for any entrepreneur. Admittedly, business success depends on the steps and degree of assertiveness of planning in the process of drawing up the business plan. Within the set of business plan assumptions, it is possible to indicate and approve the objectives, identify the internal and external risks and generate actions to reduce or even avoid them before the operation of the company. For the accomplishment of this study we used field research with an exploratory method, in a qualitative approach. As an instrument, visits were made to companies and observations of procedures for setting up a company. The result of this survey was contributed by the owner and the managing partners of the company. At the end of the research, it was evidenced that companies must establish and follow at least the basic guidelines of the business plan in order to obtain greater chances of success during its implementation.*

Keywords— *Business Plan, Entrepreneurship, Industrial Maintenance.*

I. INTRODUCTION

The successful entrepreneur needs to be very sensitive to identify new business opportunities, be dynamic and know how to turn small ideas into big business. Have the courage and perseverance to start new business or restart an idea or project, taking risks and responsibilities of the business. The term entrepreneur was first used in 1725 when economist Richard Cantillon designated the word for risk taker [1]. Over the years the process of undertaking has been the object of many studies and a number of authors have made several contributions, but to be sure, all emphasize as the key to entrepreneurship the individual with the feeling of taking risks in the business world.

In Brazil, the flexibilization of Brazilian legislation and the support of the federal government to small and micro enterprises boosted the entrepreneurial activity and encouraged the development of entities and programs to support new entrepreneurs. According to the SEBRAE report [2], between 2014 and 2017 more than one million new businesses were implemented in the form of micro

and small enterprises, the ME and EPP's. For economists at Serasa Experian there was an increase in business start-ups for the service delivery sector driven as an alternative to income generation and mainly by the slowdown of the economy in the period between 2015 and 2017.

The segment for service companies in the state of Amazonas was promising, the services sector had an increase of 8.4% according to the Brazilian Institute of Geography and Statistics (IBGE) in the same period. The volume of growth in the state was the third best in Brazil, behind only the state of Paraná (7%) and Mato Grosso (20.3%). But, not everything is wonders, it is also indicated by SEBRAE in [2] that in the first two years of life the mortality rate reaches about 70% of micro and small Brazilian companies. This corporate bankruptcy is already the object of study and discussion by business entities and universities throughout Brazil. This mortality rate of Brazilian companies is not very different from the reality pointed out by small US businesses, one of the largest supporters of microenterprises in the world, there, bankruptcy is around 50%, all this management

insufficiency is related to failures in the planning or lack of managerial experience.

In the context of business, it is noticed that the variables and degree of uncertainty of the various actions in the current world have increased and it is up to the entrepreneur to keep in tune and present differential and competitive strategies in the internal and external environment so as to maintain the expected results for design the organization in a positive way. In this study, we presented the basic premises of planning the business plan for the implementation of an industrial maintenance service company in the city of Manaus-AM. Specifically, it is necessary to: highlight the importance and advantages of planning through the business plan, identify the main characteristics of the business, competitors, analyze strengths and weaknesses, best strategies and the market scenario to make feasible or not implementation of the project.

II. THEORETICAL FOUNDATION

The need for planning with the characteristics and main points for modeling a business plan will be studied and demonstrated to show how a plan can be put together and what its contributions and relevance are to a venture. The annual report released by the GEM - Global Entrepreneurship project that measures entrepreneurial activity around the world indicates that some entrepreneurs do not consider important information about the market, do not plan the basic items, and do not manage their businesses properly. For entrepreneurs who remain on the market, the most important factor for the survival of the company is good planning before the start of operations.

According to [3], the business plan "is a document used to describe an enterprise and the business model that sustains the enterprise". The business plan is an important tool that guides and guides the entrepreneur in a simple and safe way, reducing the chances of managerial errors. In the planning phase of the plan, it is possible to identify undesirable failures, and allows the manager to create a plan of action to mitigate possible deviations in a timely manner, thus avoiding that the business can be severely affected. In addition, the study of the sections for its development contributes to the identification of the variables that can lead the business to success and to point out the possible hidden pitfalls that can be inferred in the implantation or not of the business.

In his work [4], "In the current environment, planning has become essential, because neither the waiting time nor the deficiencies of the trial and error method are acceptable" [5] defines that, The planning process is the

tool that the people and organizations use to manage their relationships with the future. It is a specific application of the decision making process. Decisions that seek in some way, influence the future, or that will be put into practice in the future, are planning decisions.

Planning in a way should provide secure avenues to maximize results and reduce the chances of errors before even the business is definitely deployed. It is necessary to choose the structure that makes up the business plan correctly, there is no standard and rigid structure for writing a business plan. Each business has its peculiarities and similarities, and it is impossible to define a standard and universal model that can be applied to any company [3]. The author also argues that the business plan must have a minimum number of sections that allow the complete understanding of the business.

III. RESEARCH METHOD

This article is characterized as a case study and has a qualitative approach of an explanatory nature, since it sought to investigate through observations, interviews and occurrences with the purpose of offering the expected results for the implementation of a service delivery company.

This type of research is concerned with identifying the factors that determine or contribute to the occurrence of phenomena. In this approach the researcher can present the reason of things through the offered results and still give continuity in studies of other researches taking into account the level of detail that is necessary.

3.1 Elements of the Business Plan

The elements of the business plan will be addressed are presented: executive summary, description of the company, product and services offered, market action, marketing and sales strategy, and financial plan.

3.1.1 Executive Summary

In his work [3], he explains that the best business plans are the most objective and his executive summary must follow this same rule, contemplating the essence of the plan, written in a clear and concise manner, so that the reader is interested in the plan. The executive summary is where you should contain, through a brief summary, the origin of the business, or the idea of the business, the services and products that will be offered, and the set of information and characteristics such as, strategies and planning for its installation, what customers must be met, the industry demand and its needs, resource estimates that will be invested, the profit margin and the time of return of the investment to the business. It represents one of the most important parts of any business plan and its planning, since it must still be developed with a simple

and objective language, but, that is able to convince the reader in the idea to be developed.

According to [1], in the executive summary the most relevant information that should be considered refers to the nature of the business and the most important aspects of the enterprise, the demands that the company will meet, the business segment, a brief report about the experience of partners of the venture and the financial resources allocated to start operations.

3.1.2 Company Description

Every business has its own characteristics and information that are part of this section, such as: legal description of the company, name, type, legal form, fiscal framework, location, sector, mission, vision, values, among others. According to [6], the company description should describe the purpose, nature of the services or products and structure. However, the most important of the description is to deal with the people who will be part of the team, and above all, the competence of the managers who will be in charge of the enterprise, since they will determine the direction of the business and therefore the focus of the investors when analyzing the proposal of business.

3.1.3 Product and services

The products and services that will be provided by the company, information on how they are produced, what resources are used for their production, how long the product or service lives, can be added the main stages of development, such as design and technologies involved in the process. In addition, customers' satisfaction and perception about the organization's products or services can be demonstrated. [7], points out that customer feedback is very important because it usually provides not only an overview of the perceived quality level in the products and services but also guides the company's future investments in new developments and processes. " In this way, the entrepreneur will have an environment with an expected horizon that will or may not launch investments and even partnerships with institutions and entities for the purpose of expanding or increasing the sales capacity of services and products.

3.1.4 Market

Market analysis can be considered the most difficult step in planning for the business plan. In order to better define the strategy to be adopted, the entrepreneur must also describe the fundamental characteristics about the environment that the company intends to operate and its executives must demonstrate through this market research, who know very well the profile of their clients and other information of the company. your product or service, how it is targeted, the market growth rate,

customer characteristics, requirements and location, whether the region or product has seasonality and how to handle such situations if you have one. The strategy to be taken can be idealized through data collection and tabulation, generating graphs and analysis of profiles of potential customers, competitors and companies established in the region of operation, and it is necessary to understand the risks that these represent for the business and highlight what measures to stand out from competitors.

Customers and markets can be studied quantitatively. To do this, you need to compile information about what and how many customers, what types and volumes of business they have with the organization, and what markets they are in. In the case of a company, this means determining the customers' participation in the billing [8]. The organization, when analyzing its strategic situation, needs to know the turnover it has with each of its clients from each of its markets [9]. The trends and fluctuations of these numbers may indicate threats or opportunities in the environment as well as weaknesses and potentialities of the organization [10].

3.1.5 Marketing and Sales

The disclosure of the product and services need to be defined in a document called a marketing plan that will contain all the objectives and actions to be developed in order to reach a particular sector for the purpose of promoting sales. Marketing strategies are the means and methods that the company should use to achieve its objectives [11].

To act in the market with a strong position, in addition to the marketing plan, it is necessary to perform a strategic analysis in such a way that the decisions provide a satisfactory result in front of its competitors. Some of the practices developed for guidance and grounding in designing the best strategies usually refer to the marketing compound, or the 4Ps: product / service, price, square, and promotion / communication.

3.1.6 Financial plan

The financial section is about presenting estimates of revenues, overhead, fixed and variable costs, marketing expenses, personnel, and projected future revenue and investment needs. In order to verify the viability of the business, in addition to collecting these data, it is necessary to identify and design indicators consistent with measurable objectives and targets that are part of the financial plan and are accounted for using the main accounting analysis methods, which are statement of income, cash and balance sheet.

IV. IMPLEMENTATION OF THE BUSINESS PLAN

The operationalization of the business plan was the fundamental basis to support the idea and promote the installation of the company providing services in the city of Manaus AM. The survey took into account the observed data referring to the market of interest where the company wished to establish itself. Therefore, a survey was made of the external scenario, the market, potential customers, competitors, strategies and other aspects that could interfere in the success of the business.

The essential topics for the elaboration of the business plan were highlighted and because it is a company oriented towards the provision of industrial maintenance services, it was decided to set up a structure with the sections, I - executive summary; II - Description of the company; III - Product and services; IV - Market; V - Marketing and sales; VI - Financial Plan.

4.1 Executive Summary

The company specializes in providing inspection services for welding, maintenance and industrial assembly. It emerged in 2018 through the experience of its managers acquired after several years of work in the area of industrial maintenance engineering and with the main purpose of meeting the demands of small, medium and large companies located in the industrial center of Manaus / AM.

The performance will be consolidated by very solid strategies, such as the high number of companies established in the industrial pole region of Manaus / AM that has to keep its equipment in good operational condition, either by periodic maintenance or by the need to increase its capacity productive. And, to meet the demand, a framework with specialized labor will be provided as a market differential, with potential for delivery of the entire scope of industrial equipment maintenance, always with a strong presence of quality in the execution, fulfillment of the deadline and cost x benefit.

4.2 Company Description

The company is a service provider of the industrial maintenance area in which it has as differential quality and immediate response in the execution of the services, trained personnel with specialized technical professionals, deadline of delivery and guarantee in the services provided. The company's mission is to integrate its employees with the company's guidelines to ensure the productivity, quality, safety and satisfaction of its customers. The vision proposed by management addresses the group's potential to become a reference in providing technical services in the industrial maintenance

segment in the city of Manaus-AM. The company's value policy seeks to maintain the best relationship among its clients and to improve service excellence, as well as to consciously use natural resources.

The organizational structure was defined considering the growth horizon predicted by the company and describes the basic sectors of the management system, below follows the functional organization chart in Figure 1 below.

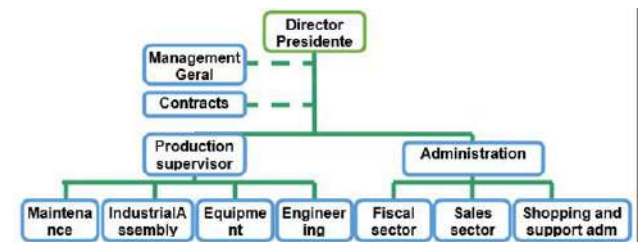


Fig. 1: Functional Organogram

The organization chart shows the proposed structure of the company with each horizontal and vertical level.

4.3 Company background

Constituted in May 2018 in the national registry of legal entities of federal revenue, with registration and business name granted for operation by the municipal government of Manaus AM. The management chose and registered its activities with legal framework in the form of individual limited liability entrepreneur - EIRELI in which establishes and regulates the operation of economic activities of a company formed by a single partner, organized to market products and services. Also as a fiscal strategy, the federal tax included the inclusion of the organization in the regime of taxation by Simples Nacional, which deals with the unification of taxes, providing benefits such as simplification of taxation, reduction of taxes, facilities for entry into new markets and differentiated conditions in banks and sources of investment.

4.4 Products and services

The services sector programs and executes the services as the main item of the scope of supply following the instructions according to standard and pre-approved procedures based on catalogs and technical norms in order to guarantee the conformity of the executed services, such as: fabrication of metallic structures, manufacture and installation of mezzanines, sheds, assembly of natural gas pipelines, compressed air and installation of industrial equipment (pressure vessels, cooling towers, heat exchangers, fuel storage tank, ASME welding technical inspection services, AWS D1.1, NBR;

Welding Visual Inspection - EVS; AWS D1.1

Ultrasonic Inspection, UT, ASME;

Magnetic Particle Inspection, PM, ASME;

Hydrostatic Testing Inspection, TH;

Inspection of Pressure Vessels and Boilers NR13

Inspection and Equipment Adequacy in accordance with NR12.

This service portfolio is made up of specific items that must be performed by specific manpower, such as mechanical engineers, equipment inspectors, ultrasonic inspectors, welding inspectors, penetrating liquid inspectors, among others, becoming a supply potential in the high value-added and low competition in the region.

4.5 Market

In a market dominated by large engineering services companies, the services sector in Brazil and specifically in the state of Amazonas has shown a slight increase in comparison with previous periods. Despite the slight growth rate, this segment is still the best option for small and medium-sized businessmen. Data from the Brazilian economy's survey report released by SEBRAE in 2018 indicate that among the most optimistic about the national economy scenario are the entrepreneurs from the northern region, small companies (EPPs), businessmen from the construction, non- opting for the simple national and SEBRAE clients.

Currently the number of companies that can be commercially exploited in the city of Manaus is very significant, a large number of customers need to contract services from third parties. And as part of the dissemination of services for this segment, managers conduct technical visits, present the portfolio of services, participate in bids and provide budgets without compromise. The main competing companies are on a horizon without much commercial strength in view of the potential of the proposed team, the quality of services and the cost-benefit offered.



Fig. 2: Location of the industrial hub of Manaus

The geographical location contributes positively, taking into account the positioning of the main industrial demand concentrated in the Manaus hub. Figure 2 indicates the location of the company's operating region.

4.6 Marketing and Sales Strategy

The marketing adopted as a reference was based on some of the characteristics of the 4Ps, shown in Figure 3, which consists of: product / service, price, market place and promotion / dissemination.



Fig. 1: 4Ps marketing compound, Source: adapted by author

Product: (of the service) To reach the objectives of the company and to meet the market demand was necessary to position the services in the target public in a way that guarantee the attendance to the requirements of the chosen segment. Establishing a positive concept with customers helped maintain a market differential and raise a level of advantage over competitors. This relationship of reference could be acquired through the diversified portfolio of services, high level of quality and better execution techniques.

Price: There is usually a variation of prices practiced by companies that operate in the industrial maintenance service segment. Therefore, the composition of prices was based on the local market cost table and the contribution margin practiced maintains a win-win trade relationship and, in a way, strengthens the expectations of its customers. The competitive price of services goes along with good quality indices and helped in market penetration.

Place: Sales and prospecting of customers are leveraged for the industries of different segments established in the industrial center of the city of Manaus-AM, such as: components and electronic products industries, non-alcoholic drinks and their concentrates, chemical and pharmaceutical, civil construction, mechanical, naval and other plastic products.

Promotion: Being a service provider is carried out on digital platforms such as social networks, search sites, engineering events and trade fairs. The sales sector maintains the disclosure via presentation card, direct mail

type mail, visits to potential companies and presentation with portfolio of services performed.

4.7 Financial Plan

The financial plan presented herein was intended to demonstrate financial transactions and cash flow, since due to its legal nature, the service provider is not required to present the income statement. The cash movements were verified by recording the recorded billing of inflows, outflows, operating costs and other expenses as fixed and variable costs. The amount estimated through the organization's history, according to the tables below, indicates the result of the current period. Table 1 of fixed and variable costs is fundamental for the entrepreneur to understand which are the main expenses that are taken into account in the implementation of the business. Initially to get the company up and running it was necessary to divide costs into three groups. It composes group 1, all items related to fixed costs and in item 2 the variable costs, while in item three all investments with machines and equipment are part. These equipments are of high importance in the business considering that they are a direct part in the execution of the services. All values are expressed in currency units.

The result of the expenses for the three groups is indicated in the column as monthly average and with individualized values, whereas the average of expenses considering a year after its operation counted the total of \$ 48,18 thousand dollars and eighteen cents for recurrent expenses.

Table. 1: Fixed and variable costs

Fixed and variable costs	Value (US\$)	
	Monthly average	Yearly
1. Fixed Costs		
Direct labor salaries	1.432,58	17.190,96
Pró-labore	1.302,35	15.628,02
third-party services (accounting)	104,19	1.250,28
Electricity	104,19	1.250,28
Water	52,09	625,08
telephone and internet	62,51	750,12
gasoline / fuel	156,28	1.875,36
	US\$	38.570,01
2. Variable costs		
Office furniture, tables and cabinets	67,72	812,64
Chairs and stringers	31,26	375,02
Other Computer Utilities	208,38	2.500,56
	US\$	3.688,22
3. Machinery and Equipment / Pre-operational		
Welding machine / rental agreement	1.562,82	18.753,84
Rotary machines, sanders and grinding machines	312,56	3.750,72
Drills, hammers and accessories	468,85	5.626,20
Ultrasonic measuring devices	312,56	3.750,72
Ink-layer measuring instruments	208,38	2.500,56
		34.382,04
Total cost (1 + 2 + 3)	US\$	76.640,27

The analyzed Revenue was formed by a mix of services with five items. In the first month of opening, in order to gain market share and boost possible sales, the portfolio of services in the market was launched with the

desire to close the first service delivery contracts. It is considered the potential of each of these specialties to be able to remain in the market. Revenue during the first period as indicated in table 2 indicates an optimistic signal in which it was confirmed by the calculation of sales by composition by gross revenue.

Table. 2: Gross revenue composition

Products / Services	Unit	Quantities	
		Monthly average	Yearly
Tooling and Machining Services	Unit	1.510,73	18.128,76
Metal Fabrication Services	Unit	2.031,67	24.380,04
Welding Inspection Services and Equipment	Unit	1.172,12	14.065,44
Machine and Equipment Installation Services	Unit	2.865,17	34.382,04
Scheduled maintenance services	Unit	1.041,88	12.502,56
TOTAL		US\$	103.458,84

Utilizing sales for the first year of deployment and projecting for the next 2 years based on data from the cash flow recorded in table 3 for the 36-month period, compared there was an increase of about 33.56% in the first year, from the second to the third one it is noticed that the result has been maintained.

Table. 3: Cash Flow Projection

CASH FLOW	1 year	2 year	3 year
RECIPE	103.458,84	117.187,50	111.979,16
EXPENSES	76.640,27	76.822,91	71.614,58
RESULT	US\$ 26.818,57	US\$ 40.364,58	US\$ 40.364,57

The movement of the cash flow, as well as the projected horizon of revenue, makes it possible to infer that the business now implanted proved to be viable once it obtained positive results, without the need for financing such as investment banks and resources. However, if necessary, make a plan for the acquisition of machines and tools.

V. FINAL CONSIDERATIONS

Facing the difficulties, there are many challenges for companies and entrepreneurs, they need to be prepared to face this market, diversified and very competitive, that do not allow the success of anyone who does it anyway, without a pattern, without clear and defined criteria and mainly without planning and quality.

The decline of the entrepreneur is often related to the lack of effective planning and a realistic analysis of the market at all times, which would probably increase the chances of survival, since the planning of the main steps is essential and basic item for the organization, however small or large, remains competitive in the market.

Therefore, for existing or future enterprises, planning should be used in an objective way, as well as the business plan as a management tool to implement, maintain and increase the degree of success of the

business decisions, so that these are more assertive and also to detect possible threats of the business, thus avoiding problems and possible damages in the future, that could jeopardize the life of the business so desired.

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REFERENCES

- [1] CHIAVENATO, Idalberto. Empreendedorismo: dando asas ao espírito empreendedor: empreendedorismo e viabilidade de novas empresas: um guia eficiente para iniciar e tocar seu próprio negócio. 2007.
- [2] ÀS MICRO, Serviço Brasileiro de Apoio; EMPRESAS, Pequenas. Sebrae. Prática de ensino: Programa de Mentoria. Brasília, 2015.
- [3] DOLABELA, Fernando. Oficina do Empreendedor. Rio de Janeiro: Sextante, 2008.
- [4] MÜLLER, Cláudio José. Planejamento Estratégico, Indicadores e Processos-Uma integração necessária. Revista Brasileira de Contabilidade, n. 220, p. 94-94, 2016.
- [5] MAXIMIANO, Antonio César Amaru. Introdução à administração/Antonio César Amaru Maximiano.-3 ed. rev. e ampl. São Paulo: Atlas, 2000.
- [6] MELO, Natália Maximo et al. Sebrae e empreendedorismo: origem e desenvolvimento. 2008.
- [7] MONITOR, Global Entrepreneurship. Empreendedorismo no Brasil: 2010. Relatório Nacional. Curitiba: Instituto Brasileiro da Qualidade e Produtividade, 2010.
- [8] RICCA, José Luiz. Sebrae: O jovem empreendedor. Estudos Avançados, v. 18, n. 51, p. 69-75, 2004.
- [9] MAXIMIANO, Antonio César Amaru. Introdução à administração/Antonio César Amaru Maximiano.-3 ed. rev. e ampl. São Paulo: Atlas, 2000.
- [10] SOARES, Tânia Cristina Lemes. Introdução à administração. 2018.
- [11] Dornelas, José Empreendedorismo: transformando ideias em negócios. José Dornelas – 6. ed. – São Paulo: Empreende/Atlas, 2016.

A Survey on Filtered Watermarking Embedding & Extraction in Bit Planes

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Abstract— Now a days the image authentication through watermarking is going in many different techniques. One of the newest method is filtered watermarking. The filtered watermarking is a secured watermarking technique. Depending upon the type of filter used during the watermarking process, the overall watermarked images results will be changed. Actually the target information is present in the edges of the watermark image in filtered watermarking process. The watermark image is hidden into another cover image(original image). The extraction of target information by using various edge detecting filters produce various results. In this paper we discussed our survey results on watermark embedding and extraction in bit planes using different filters and also the embedding of the filtered watermark in various order bit planes.

Keyword---watermarking, Watermarking Embedding, authentication.

I. INTRODUCTION

Now a days for image security and authentication, watermarking is widely used process. There are many watermark embedding and extraction processes, one of the newest watermarking technique is filtered watermarking process. The watermark undergoes a filtering operation to detect the information which is mostly present in the edges of the watermark image. the detection of edges can be performed by using different filters. In this paper we discussed on four different edge detection filters for the watermarking process. The filters applied during the watermarking process are Sobel edge detector, Prewitt edge detector, Canny edge detector and Robert's edge detector. Before watermark embedding onto original image (cover image), the watermark is filtered for target information identification. The original image(cover image)goes under bit plane slicing operation before filtered watermark embedding into it. The original image (cover image) has a capacity has a capacity to hide a watermark into it. The final watermarked image is obtained by embedding the cover image and edge detected watermark image. The error metrics like Mean Square Error, Peak Signal to Noise Ratio are calculated and discussed in the following sections.

II. PROPOSED METHOD

The filtered watermark embedding and extraction in bit planes uses different filters for edge detection. The block diagram of the proposed method is shown in fig 2.1.

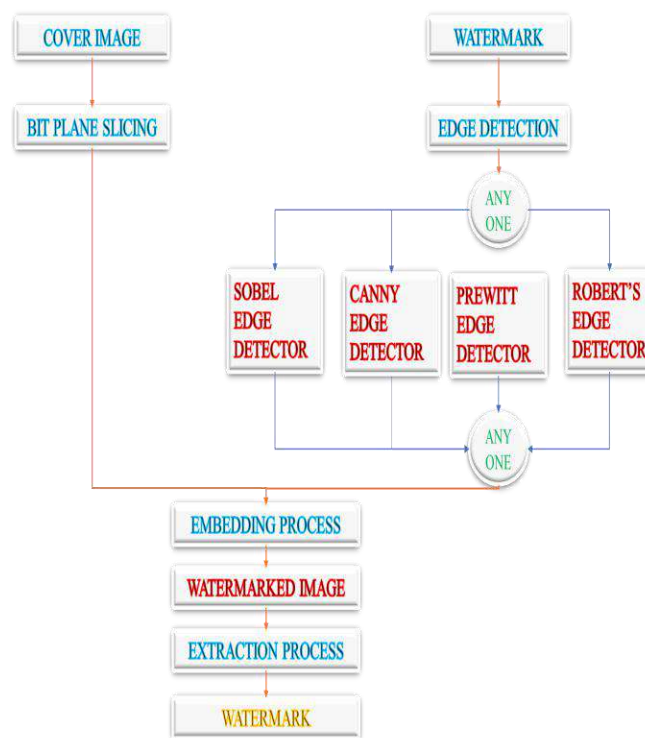


Fig.2.1. Block diagram of the proposed method.



Fig2.2. Cover Image.



Fig.2.3. Watermark Image Before Edge Detection.



Fig2.4. Sobel Filtered Watermark.



Fig2.5.Canny Filtered Watermark.



Fig.2.6.Prewitt Filtered Watermark.



Fig.2.7.Roberts Filtered Watermark.

The watermarking process has two images as input images. One of the image is cover image which is having a capacity to hide another image into it. This cover image goes under bit plane slicing process. The cover image is represented in pixels and each pixel is represented in bit format. According to the position of bits (in case of eight bit representation the total no. of bits are eight) different bit plane sliced images are formed. The image obtained by higher order bits i.e. MSB's has high visual appearance than the image obtained by lower order bits i.e. LSB's. the lower order bits has low amount of information. The watermark which is to embed into cover image goes under any one edge detection technique. In this proposed survey, we used four types of edge detection filters to extract the edges. The used filters are sobel edge detector, canny edge detector, prewitt edge detector & robert's edge detector. The edge detected watermark embedded in different bit planes produces different images as outputs. Each output image is differ from each other.

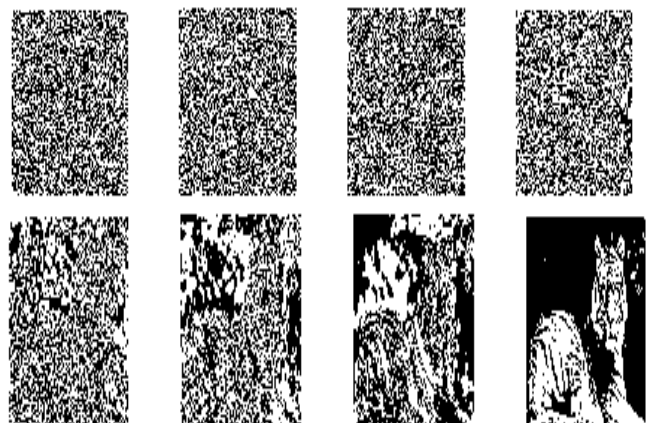






Fig2.8. Bit Plane Sliced Images of Cover Image.(order from LSB's to MSB's)


The extraction of the watermark works exactly opposite to the watermark embedding process. The Mean Square Error, Peak Signal to Noise Ratio are calculated to compare the cover image before adding the watermark and the final watermarked image. the results of our survey are discussed in the section-III.

III. RESULTS

The results of our survey are explained in this section in detail. We tabulated watermarking results in bit planes along with the PSNR and MSE values.

BIT PLANE NUMBER	WATERMARKED IMAGE (SOBEL FILTER)	MEAN SQUARE ERROR (dB)	PEAK SIGNAL TO NOISE RATIO (dB)
7		2116.19	14.91
8		6412.75	10.09
BIT PLANE NUMBER	WATERMARKED IMAGE (CANNY FILTER)	MEAN SQUARE ERROR (Db)	PEAK SIGNAL TO NOISE RATIO (Db)

7		2092.06	14.96
8		6495.25	10.04

BIT PLANE NUMBER	WATERMARKED IMAGE (PREWITT FILTER)	MEAN SQUARE ERROR (dB)	PEAK SIGNAL TO NOISE RATIO (dB)
7		2113.56	14.91




8		6428.25	10.08
BIT PLANE NUMBER	WATERMARKED IMAGE (ROBERTS FILTER)	MEAN SQUARE ERROR (dB)	PEAK SIGNAL TO NOISE RATIO (dB)
7		2089.50	14.96
8		6512.50	10.03

Table.3.1. Survey Results of Filtered Watermark Embedding and Extraction in Bit Planes.

IV. CONCLUSION

In this paper we discussed the survey results of filtered watermarking embedding and extraction in bit plane slicing. In our results we selected as the cover image goes under bit plane slicing and in this paper the bit planes seven and eight are taken for embedding the filtered watermark. In this paper the Roberts edge detection method gives a low Peak Signal to Noise Ratio value as

10.03dB and then next canny edge detection method gives a Peak Signal to Noise Ratio as 10.04dB.

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BIBLIOGRAPHY

- [1] R. E. W. 3. E. Rafael C. Gonzalez, Digital Image Processing, india: Dorling Kindersley (India) Pvt.Ltd, 2013.
- [2] I. S. A. R. L. G. Langelaar, "Watermarking Digital Image And Video Data," *IEEE Signal Processing Magazine*, vol. 2046, p. 17, 2000.
- [3] R. E. W. S. L. E. M. H. Rafael C. Gonzalez, Digital Image Processing Using MATLAB, Mcgraw Hill, 2010.
- [4] ". Gregory Kipper, "Investigator's Guide To Steganography," *IEEE Journal Of Selected Areas In Comm*, 1999.
- [5] A. P. ., Stefan Katzenbeisser And Fabien, "Information Hiding Techniques For Steganography And Digital Watermarking".
- [6] P. Tucker., "Hiding Secrets In Computer Files: Steganography Is The New Invisible Ink, As Codes Stow Away On Images".
- [7] M. I. N. M. M. I. A. B. S. M. Ismail Avcýbas,," Steganalysis Using Image Quality Metrics," *IEEE Transactions On Image Processing*, , Vols. "Vol 12, No. 2,, February 2003.
- [8] .. Neil F. Johnson And Sushil Jajodia, " "Exploring Steganography: Seeing The Unseen", " *IEEE*, 1998..
- [9] U. O. M. Niels Provos And Peter Honeyman, " "Hide And Seek: An Introduction To Steganography", " *IEEE Computer Society IEEE Security & Privacy*..
- [10] C. A. JI. Dugelay, " A Survey Of Watermarking Algorithms For Image Authentication," *Eurasip Journal On Applied Signal Processing*, vol. 613621, p. 6, 2002..
- [11] N. F. J. A. S. Jajodia, " Exploring Steganography: Seeing The Unseen," *IEEE*, 1998..
- [12] R.J. Anderson And F.A.P. Petitcolas, "On The Limits Of Steganography," *IEEE Journal Of Selected Areas In Comm*, pp. 474-481., 1998.
- [13] R. Chandramouli And Nasir Memon, " Analysis Of Lsb Based Image Steganography Techniques," *IEEE* , 2001.
- [14] N. Sasikala, D. Sharathchandra, Y. Murali Krishna "Sobel Filtered Watermark Embedding and Extracting in Bit Planes – Optimization of PSNR" *IJSRD - International Journal for Scientific Research & Development*| Vol. 7, Issue 01, 2019 | ISSN (online): 2321-0613

Antioxidant, antibacterial, leishmanicidal and trypanocidal activities of extract and fractions of *Manilkara rufula* stem bark

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Abstract—*Manilkara rufula* belongs to family Sapotaceae and has received little attention regarding its pharmacological properties and chemical composition. Therefore, our objective was to determine the pharmacological activities and preliminary chemical profile of the stem bark from *M. rufula*. The plant stem bark of *M. rufula* was collected and ethanolic extract and fractions were prepared. The antioxidant activity was determined by •DPPH and ABTS•+ scavenger methods and inhibition of β -carotene oxidation. The minimum inhibitory and bactericidal concentrations were estimated through the broth microdilution method against gram positive and negative bacteria. Cytotoxicity, antioxidant and cytoprotection potential were investigated on culture macrophages. Antiproliferative activity was evaluated by Alamar Blue method. The in vitro arginase activity from *Leishmania amazonensis* was determined in presence of the samples. In addition, their effects on survival of *L. amazonensis* and *Trypanosoma cruzi* amastigotes in mice macrophages were assessed. The preliminary phytochemical profile was evaluated by qualitative methods of classical phytochemistry, infrared spectroscopy, LC-MS/MS and CG-MS. The samples presented antioxidant, bactericidal, leishmanicidal and trypanocidal properties without toxic characteristics on normal cells. Triterpenes were observed in the hexane fraction, while glycosides, aromatic rings, fatty esters, proanthocyanidin dimers and trimers, catechin and various terpenes were observed in the other fractions.

Keywords—Sapotaceae, *Manilkara rufula*, pharmacological activities, chemical composition.

I. INTRODUCTION

Sapotaceae is a family with approximately 1000 trees and shrubs species, distributed in 50 genera, latex producers and ecologically important for their area of occupation. In addition, some species of this family are employed in folk medicine, ornamentation and animal feeding (Kuera et al., 2002; Araújo Neto, 2009). The most important genera of this family in Brazil are *Pouteria*, *Sideroxylon* and *Manilkara* (Gomes et al., 2003).

The genus *Manilkara* has 19 species identified in Brazil, distributed in the Atlantic Forest, sandbanks, coast al tableland forests, Caatinga, Cerrado and Amazonian

Forest. In the Northeast region, twelve *Manilkara* species have already been confirmed in different ecosystems. The plants of this genus have been described to have anti-inflammatory, antiparasitic, antitumor, antibacterial and antioxidant properties, mainly due to the presence of various secondary metabolites, such as flavonoids, phenolic acids, saponins and triterpenes (Gomes et al., 2003; Ma et al. 2003; Eibond et al., 2004).

Among the species belonging to this genus, *M. rufula*, popularly known as "maçaranduba", stands out. This is a 5 to 10-meter-high tree that is very often used for logging, but with no references of popular use as medicinal plant.

Regarding the pharmacological activity and chemical composition of *M. rufula*, a recent study showed the trichomonocidal effect of some compounds isolated from the plant stem, whereas its methanolic extract was demonstrated to have low activity against *S. aureus*, *E. coli* and *K. pneumonia* strains (de Souza, 2015; Vieira et al., 2016).

Therefore, the objective of this study was to determine the antioxidant, bactericidal, leishmanicidal, trypanocidal and antiproliferative (to cancer cells) activities, as well as the preliminary phytochemical profile, of the stem bark of *M. rufula*, a plant that has been poorly studied so far, in order to contribute to the discovery of bioactive molecules particularly in species present in the semi-arid region of Bahia State.

II. MATERIAL AND METHODS

A. Collection and botanical identification

Specimens of *M. rufula* were collected in the municipality of Maracás in Bahia State, Brazil Northeastern (13°26'27"S 40°25'51"O) in September 2015. Multiple plants were identified at the harvesting site and one representative voucher specimen was deposited in the Herbarium at State University of the Southwest of Bahia under number 12455. Plant materials were formally identified by Guadalupe Edilma Licon de Macedo, PhD, Full Professor at the Department of Biological Sciences, State University of the Southwest of Bahia. The collection was approved by Brazilian Genetic Heritage Management Council (CGEN 010557/2015-6).

B. *M. rufula* sample and fractionation

The stem bark of *M. rufula* (50 g) was extracted three times with absolute ethanol for 72 h and filtered to obtain the ethanolic extract of *M. rufula* (EEMR = 23.3%). EEMR was fractionated via liquid-liquid partitioning with hexane, ethyl acetate, methanol and hydroalcoholic solvents in order of increasing polarity to obtain hexane (HFMR = 21.0%), ethyl acetate (EAFMR = 20.7%), methanol (MFMR = 45.1%) and hydroalcoholic fractions of *M. rufula* (HAFMR = 6.3%) (Kuroshima, 2002; Silva et al., 2014). Solvents were purchased from Synth (Sao Paulo, Brazil) from analytical grade or better.

C. Quantification of total phenols method

Total phenols in samples was determined by Folin-Ciocalteu method, with minor modifications (Singleton et al., 2002). The samples were diluted in ethanol to a final concentration of 1 mg/mL. In assay tubes, 125 μ L of each sample were mixed with 125 μ L of Folin-Ciocalteu reagent (Sigma-Aldrich, St. Louis, MO, USA) and 1 mL of distilled water. After 3 min, 125 μ L of a saturated solution of Na₂CO₃ were added and the samples were incubated at

37°C. After 30 min, the absorbance of samples was measured at 750 nm. The amount of total phenols in samples was determined based on the standard curve of gallic acid (0.5 at 25 μ g; Sigma-Aldrich, St. Louis, MO, USA) and expressed as equivalent μ g of gallic acid per milligram of sample (μ g GAE/mg). The calibration curve equation for gallic acid was $y = 0.066x + 0.0651$, $R^2 = 0.9805$.

D. Qualitative phytochemical study

Extract and fractions of the stem bark of *M. rufula* were analyzed by thin layer chromatography for qualitative identification of alkaloids and flavonoids, with specific developers for each class. The samples were previously solubilized in methanol, except for the hexane fraction, which was solubilized in chloroform. They were then plated with silica gel (stationary phase) and eluted in a glass vat containing an ethyl acetate: methanol (8:2, Synth, Sao Paulo, Brazil) mixture. The plates were observed under UV light 254 nm and 365 nm and then sprayed with the NP-PEG (1% diphenylboryloxyethylamine in methanol, followed by 5% polyethylene glycol 4000 solution in ethanol) and Dragendorff reagents for discovery of flavonoids and alkaloids, respectively (Wagner and Blad, 2009).

The presence of triterpenes was evaluated by Liebermann-Burchard method. About 2 mg of extract and fractions were diluted in 2 mL of chloroform (Synth, Sao Paulo, Brazil). Then, 4 mL of acetic anhydride (Synth, Sao Paulo, Brazil) and 4 drops of sulfuric acid (Synth, Sao Paulo, Brazil) were added. The presence of triterpenes was indicated by the change from blue to green (Matos, 1997).

E. Infrared spectroscopy

Infrared analyzes were performed using the Perkin Elmer spectrophotometer model Spectrum Two ATR-FTIR, with horizontal attenuated total reflectance accessory employing a zinc selenide crystal. The spectra were obtained by spreading the sample onto the crystal surface of ATR. For each analysis, the cell was cleaned with acetone (Synth, Sao Paulo, Brazil). All spectra were obtained in the region of 4000 to 500 cm⁻¹, with resolution of 4 cm⁻¹ and 32 scans (Ruschel et al., 2014).

F. LC-MS/MS

Chromatographic analyses of samples were performed using a UPLC Acquity chromatograph coupled with a TQD Acquity mass spectrometer (Micromass-Waters), with an electrospray ionization (ESI) source in the negative mode. The column was a Phenomenex Luna C-18 (250x4.6 mm, 5 μ m). The mobile phases were formic acid/water (phase A) and acetonitrile/formic acid (phase B). The flow rate was 1 mL/min with a

linear gradient starting at 0% B and increasing to up 100% in 60 min, before holding until 5 min, and then returning to initial conditions, followed by column re-equilibration. The ESI conditions were: capillary = 4.5 kV, cone = 30 V, source temperature = 300 °C, desolvation temperature = 300 °C, and collision energy = 30 V, with data acquisition between m/z 50 and 1000. The components of *M. rufula* samples were putatively identified by comparing their m/z values and fragmentation patterns with previous reports.

G. CG-MS

The identification of the compounds in the hexane fraction from *M. rufula* stem bark was performed after separation by high resolution gas chromatography with the capillary column "Rtx – 5MS" – 30 m (length) x 0.25 mm (internal diameter) x 0.25 μ m (film thickness) nominal, helium gas as drag gas coupled to a mass detector (CG-MS Model QP2020, Shimadzu, Kyoto, Japan). The identification of compounds was performed by comparing the mass spectra of the samples with those found in NIST version 14.

H. Determination of antioxidant activity

The antioxidant activity of *M. rufula* samples were evaluated using three well-known methods: •DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging, ABTS^{•+} (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid cation radical) decolorization and β -carotene-linoleic acid cooxidation assays (Marco, 1968, Miller, 1971).

In the DPPH assay, the samples (1.25-150 μ g mL⁻¹) were incubated to 2 mL of an ethanolic solution of •DPPH (Sigma-Aldrich, St. Louis, MO, USA) (70 μ M). After 20min at 25°C, the absorbance was measured at 517 nm. In the ABTS^{•+} assay, we first prepared ABTS radical cation by reacting 7 mM ABTS salt (Sigma-Aldrich, St. Louis, MO, USA) with 2.45 mM potassium persulfate (Synth, Sao Paulo, Brazil) and allowing the mixture to stand in the dark at room temperature for 16 h before use. The stock ABTS^{•+} solution was diluted with ethanol (absorbance of 0.7 at 734 nm) and incubated to samples (1.25-150 μ g mL⁻¹) in a final volume of 2 mL. The absorbance was measured at 734 nm after 7 min of incubation.

In the β -carotene-linoleic acid cooxidation assay, a stock solution of β -carotene/linoleic acid was initially prepared by dissolving 2 mg of β -carotene (Sigma-Aldrich, St. Louis, MO, USA) in 100 μ L of chloroform (Synth, Sao Paulo, Brazil). Ten microliters of β -carotene solution were mixed to 40 mg of linoleic acid and 530 μ L of Tween 40 (Sigma-Aldrich, St. Louis, MO, USA). The chloroform was rotaevaporated and aerated distilled water was added to the mixture until an initial absorbance of 0.65 at 470 nm. Two milliliters of β -carotene/linoleic acid emulsion were mixed with the samples (1.25-150 μ g mL⁻¹). The

reactions were incubated at 50 °C for 2 h before taking another absorbance reading.

In all experiments, the values were expressed as the concentration of sample necessary to reduce 50% the free radicals or the β -carotene bleaching (IC₅₀). Gallic acid was used as control in •DPPH and ABTS^{•+} methods, while Trolox, in the β -carotene bleaching assay.

I. Cell culture assays

A monocyte cell line THP-1 (human leukemia monocytes) was obtained from Instituto de Química, Universidade de São Paulo (São Paulo, Brazil). THP-1 was grown in DMEM (Gibco-BRL, Gaithersburg, MD, USA) with 10% fetal bovine serum (FBS), 100 U mL⁻¹ penicillin and 100 μ g mL⁻¹ β -marcaptoethanol (all from Sigma-Aldrich, St. Louis, MO, USA) at 37 °C in a 5% CO₂ atmosphere. THP-1 monocytes (2x10⁶ mL⁻¹) were differentiated into macrophages by medium supplementation with phorbol-12-myristate-13-acetate (PMA, 5 ng mL⁻¹, Sigma-Aldrich, St. Louis, MO, USA) and incubated for 2 days at 37 °C under 5% CO₂. The adhered cells were collected by trypsinization (Park et al., 2007).

The cell viability was first determined by lactate dehydrogenase assay.¹⁷ The cells (1x10⁵ well⁻¹) were dropped into 96-well plates and pre-incubated with the extract and fractions of *M. rufula* at concentration of 10, 50 and 100 μ g mL⁻¹ at 37 °C for 24 h. Afterwards, the supernatant was collected and the lactate dehydrogenase was determined by using a biochemical kit (Labtest). As positive control, the cells were incubated with Triton X-100 (1%) (Sigma-Aldrich, St. Louis, MO, USA).

J. Citoprotective and antioxidant activities

Macrophages (1x10⁵ well⁻¹) derived from THP-1 cell line were placed into a 96-well plate and pre-incubated at 37 °C with extract and fractions of *M. rufula* (50 μ g mL⁻¹). For the cytoprotective assay, cells were washed twice in phosphate-buffered saline (PBS) (Sigma-Aldrich, St. Louis, MO, USA) 24 h later. The medium was replaced, and H₂O₂ (Synth, Sao Paulo, Brazil) (1 mM) was added, following incubation for 18 h. The residual cell viability was determined as described above (Facundo et al., 2007).

To determine the antioxidant activity of isolated extract and fractions in cells, the same procedure was performed. After incubation with H₂O₂, the cells were washed in PBS, incubated in 2',7'-dichlorofluorescein diacetate (DCFH-DA; Molecular Probes, Eugene, OR, USA) at 10 μ M for 1 h at 37°C in a dark chamber. The extracellular DCFH-DA was removed after washing the cells twice in PBS. The oxidation of DCFH was determined by fluorescence (λ_{ex} =485 nm; λ_{ex} =520 nm) using a microplate reader, since the fluorescent signal indicates the intracellular redox state. In both assays, ethanol (5%) and tempol (10 μ M)

were selected as negative and positive controls, respectively (Jeong et al., 2009).

K. Hemeoxygenase activity

Cells (5×10^5 well⁻¹) were pre-incubated for 24 h with fractions at $50 \mu\text{g mL}^{-1}$ or tempol ($10 \mu\text{M}$). Afterwards, the harvested cells were subjected to three cycles of freeze-thawing before addition to a reaction mixture consisting of phosphate buffer (1 ml final volume, pH 7.4) containing magnesium chloride (2 mM), NADPH (0.8 mM), glucose-6-phosphate (2 mM), glucose-6-phosphate dehydrogenase (0.2 U), rat liver cytosol as a source of biliverdin reductase, and the substrate hemin ($20 \mu\text{M}$). The reaction mixture was incubated in the dark at 37°C for 1 h and was terminated by the addition of 1 mL of chloroform. After being vigorously vortexed and centrifuged, the extracted bilirubin in the chloroform layer was measured by the difference in absorbance between 464 and 530 nm ($\epsilon = 40 \text{ mM}^{-1} \cdot \text{cm}^{-1}$) (Jeong et al., 2009).

L. Suscetibility testing

The antibacterial activity of EEMR and fractions were examined by determining the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC), according to the Institute of Clinical and Laboratory Standards (Santos et al., 2017). To determine the MIC, 5×10^5 CFU mL⁻¹ diluted in brain heart infusion medium (Difco, USA) were incubated with EEMR and fractions ($1\text{--}1000 \mu\text{g mL}^{-1}$) in 96-well microplates for 24 h at 37°C . The vehicle control was ethanol (5%). MIC was defined as the lowest concentration of EEMR or fraction that allowed no visible growth after incubation with 0.01% resazurin dye (Sigma-Aldrich, St. Louis, MO, USA) for 60 min at room temperature. MBC was determined by sub-culturing $10 \mu\text{L}$ of each incubated well that had a concentration higher than the MIC on Müller-Hinton agar. The MBC was then treated as the lowest concentration of each sample with no visible colony growth on agar plates.

The bacterial strains used in this study were *S. aureus* (ATCC 29213), *K. pneumoniae* (ATCC 25922), *P. aeruginosa* (ATCC 27853), *E. coli* (ATCC 25922) and *P. mirabilis* (ATCC 17407) and were kindly provided by Prof Dr Milena Soares dos Santos, Instituto Multidisciplinar em Saúde, Universidade Federal da Bahia.

M. Antiproliferative activity to cancer cells

The antiproliferative effect of EEMR was determined in cancer cell lines HepG2 (human hepatocellular carcinoma) and HL-60 (human promyelocytic leukemia). These cell lines were kindly provided by Hospital A.C. Camargo (São Paulo, SP, Brazil) and maintained in Roswell Park Memorial Institute-1640 (RPMI-1640, Gibco-BRL, Gaithersburg, MD, USA) medium

supplemented with 10% FBS (Cultilab, Campinas, Sao Paulo, Brazil), 2mM-glutamine (Vetec Química Fina, Duque de Caxias, Brazil), and $50 \mu\text{g/mL}$ gentamycin (Novafarma, Anapolis, Brazil). All cell lines were cultured in cell culture flasks at 37°C in 5% CO₂ and subcultured every 3–4 days to maintain exponential growth. (The cells were plated in 96-well plates (3×10^5 cells mL⁻¹ for HL-60 and 7×10^4 cells mL⁻¹ for HepG2) and, after 24 h, samples solubilized in DMSO ($50 \mu\text{g mL}^{-1}$, Synth, Sao Paulo, Brazil) were added into each well and incubated for 72 h. Four hours before the end of the incubation period, resazurin (0.312 mg mL^{-1} , Sigma-Aldrich, St. Louis, MO, USA) was added into each well and the absorbance was measured at wavelengths of 570 nm (reduced) and 595 nm (oxidized) using a plate reader (Ahmed et al., 1994; Rodrigues et al., 2015).

Doxorubicin ($5 \mu\text{g mL}^{-1}$) and DMSO (0.5%) were used as positive and negative controls, respectively. The results were expressed as percentage of inhibition of cell proliferation in cancer cell lines.

N. Inhibition of Leishmania arginase

Recombinant arginase from *Leishmania amazonensis* (ARG-L) was prepared according previously described (da Silva et al., 2008; da Silva et al., 2012). The inhibition test for ARG-L were performed at pH 9.5 in CHES (2-(Cyclohexylamino)ethanesulfonic acid, 50 mM, Sigma-Aldrich, St. Louis, MO, USA) buffer with L-arginine (50 mM; Sigma-Aldrich, St. Louis, MO, USA), ARG-L and samples. The reaction mixtures were incubated in a 37°C water bath for 15 min. The quantity of the enzyme used was adjusted to 10% of the maximum consumption of L-arginine substrate. Quantification of urea production was performed by the method described by Berthelot (Fawcett and Scott, 1960; Manjolin et al., 2013). Briefly, arginase catalytic capacity was stopped by transferring $10 \mu\text{L}$ of the reaction mixture into $750 \mu\text{L}$ of reagent A (20 mM phosphate buffer pH 7, containing 60 mM salicylate, 1 mM sodium nitroprusside and 500 IU of uréase; Labclin, Sao Paulo, Brazil). This mixture was incubated at 37°C for 5 min. Next, $750 \mu\text{L}$ of reagent B (10 mM sodium hypochlorite and 150 mM NaOH; Labclin) was added, and the samples were incubated at 37°C for 10 min. The absorbance was measured at 600 nm using a GEHAKA 340G spectrophotometer. The positive and negative controls were performed under the same conditions in the absence of inhibitor. The experiments were performed in triplicate in at least two independent experiments.

O. Leishmanicidal activity

Peritoneal exudate macrophages were obtained by injection of thioglycolate (3%) into the peritoneal cavity of

Male BALB/c mice (n=2; 2 months; 20-25 g) to induce inflammation and migration of macrophages into the region. After 4 days, mice were euthanized by exposure to a carbon dioxide chamber and the macrophages were collected from the peritoneal cavity by using a serynge and the cells were cultured (Gomes et al., 2003). The animals were obtained from Gonçalo Moniz Institute/Fiocruz vivarium, housed at eight per cage, kept at 24±2 °C with a 12/12-h light/dark cycle and provided with water and chow *ad libitum*. This procedure was approved by Ethics Committee on the Use of Animals (CEUA) of the Gonçalo Moniz Institute/Fiocruz under the number 1126 e performed at Laboratório de Engenharia Tecidual e Imunofarmacologia (Fiocruz).

Briefly, the exudate cells were recovered by peritoneal lavage with sterile saline. Cell suspension was then centrifuged at 1500 rpm for 10 min at 4 °C and the pellet was resuspended in DMEM medium (Sigma-Aldrich, St. Louis, MO, USA). After counting in a Newbauer camera, cells were plated in 96-well plates (5x10⁴/well) in DMEM medium and incubated for 16 h at 37 °C under CO₂ atmosphere (5%). Plates were then washed three times with warm saline to remove non-adherent cells. The macrophages were infected with stationary growth phase promastigotes of *L. amazonensis* at a ratio of 5:1 macrophage. The co-culture was then incubated at 35°C under CO₂ atmosphere (5%) during 24 h, followed by washing to remove the non-internalized parasites.

Infected macrophages were incubated with the plant extract and fractions (20 µg mL⁻¹) in DMEM medium for 72 h at 37 °C. The wells were then washed with saline solution, fixed with paraformaldehyde solution (4%; Sigma-Aldrich, St. Louis, MO, USA) and stained with Draq5 (5µM, Biostatus, United Kingdom) to label the cellular DNA. Then, the amount of amastigotes and macrophages in each well was counted in the Operetta High-Content Imaging System (Perkin Elmer, Massachusetts, USA) confocal microscope. Amphotericin B (1 µM; Gibco-BRL, Gaithersburg, MD, USA) was used as a positive control (Chaves et al., 2009). The infectivity index of the parasite was determined by multiplying the mean number of amastigotes per cell by the percentage of infection (Tanaka et al., 2007). The percentage inhibition of this index was then calculated.

P. Anti-*T. cruzi* activity

Murine macrophages adhered in plaque (6x10³ well⁻¹) were infected with *T. cruzi* Y strain trypomastigotes (6x10⁴ trypomastigotes well⁻¹) for 24 h. The wells were then washed three times with sterile saline and cells were incubated with the extract and fractions (100 µg mL⁻¹) for 72 h at 37 °C under CO₂ atmosphere (5%) in DMEM

medium. The wells were then washed with saline, fixed with 4% paraformaldehyde solution and stained with Draq5 (4 µM). Quantification of amastigotes and macrophages was performed on the Operetta High-Content Imaging System confocal microscope and the data were expressed as infectivity index. Benzonidazole (5 µM) was used as positive control (Bastos, 2013).

This procedure was also approved by Ethics Committee on the Use of Animals (CEUA) of the Gonçalo Moniz Institute /Fiocruz under the number 1126.

Q. Statical analysis

Data were expressed as the mean ± standard deviation or IC₅₀ values based on three independent experiments. Significant differences (*p* < 0,05) were detected by one-way ANOVA with Dunnet post-test using GRAPHPAD Prisma (5.0), using significance of 5%. The correlation between antioxidant, trypanocidal and leishmanicidal activity and phenolic content were determined by the Pearson correlation test with significance of 5%.

III. RESULTS

R. Determination of total phenolic and antioxidant activities

The concentration of phenolics in the extract and fractions of the stem bark of *M. rufula* is shown in Table 1. The AEFMR fraction had the highest phenolic concentration in the samples (143 µg EAG mg⁻¹), whereas HFMR contained about 5 times less phenolic compounds (29 µg EAG mg⁻¹).

Extracts and fractions of *M. rufula* were evaluated by three different antioxidant methods: •DPPH and ABTS•+ free radical scavenging and inhibition of lipid peroxidation. All samples were able to deactivate •DPPH and ABTS•+ radicals and inhibit β-carotene oxidation by lipid radicals (Table 1). The MFMR fraction was the most potent in reducing the •DPPH (IC₅₀ = 3 µg mL⁻¹) radical compared to the gallic acid standard (IC₅₀ = 1.5 µg mL⁻¹). In addition, it was also the most effective fraction in inhibiting the β-carotene decay, with 20 times more potency than trolox standard (IC₅₀ = 21µg mL⁻¹). In the case of the ABTS•+ method, the hexane fraction unexpectedly reduced the radical with IC₅₀ of 0.12 µg mL⁻¹, but reacted with •DPPH at higher concentrations (IC₅₀ = 60 µg mL⁻¹).

In the comparison between the content of reducing compounds, among them phenolics, with the antioxidant activity, the results of the •DPPH and ABTS•+ assays were not correlated with the concentration of these compounds (*r* = 0.643 and *p* = 0.241 and *r* = 0.645 and *p* = 0.239, respectively). On the other hand, there was a correlation between these compounds and the β-carotene co-oxidation

assay ($r = -0.929$ and $p = 0.022$), which suggests that the reducing compounds of the Folin-Ciocalteu reagent are also important in the protection against oxidation of β -carotene.

S. Cell viability, cytoprotection and antioxidant activity in cell model

The extract and fractions ($50 \mu\text{g mL}^{-1}$) of the stem bark of *M. rufula* were effective in protecting macrophage-differentiated THP-1 against H_2O_2 -induced cell death when pre-incubated for 24 h with the cells before oxidant addition (Fig. 1A). In particular, the ethyl acetate fraction

protected the cells in approximately 83%. Furthermore, this fraction inhibited the intracellular oxidation of DCFH mediated by H_2O_2 in these cells exposed to samples ($50 \mu\text{g mL}^{-1}$) was also greater for the ethyl acetate fraction (Fig. 1B). The activity of an important antioxidant and cytoprotective enzyme, hemeoxygenase, increased almost twice when the cells were pre-incubated with the same fraction (Fig. 1C).

It is important to note that, even under concentrations of up to $100 \mu\text{g mL}^{-1}$ of the extract or fraction of *M. rufula* stem bark, THP-1-derived macrophages remained viable ($> 90\%$).

Table 1. Total phenolics and antioxidant activities of the *M. rufula* stem bark and fractions.

Sample	Total Phenolics $\mu\text{g GAE mg}^{-1}$	$\bullet\text{DPPH IC}_{50}$ ($\mu\text{g mL}^{-1}$)	ABTS \bullet^+ IC_{50} ($\mu\text{g mL}^{-1}$)	β -carotene-linoleic acid cooxidation ($\mu\text{g mL}^{-1}$)
EEMR	42.6 \pm 0.1	11 \pm 1	1.68 \pm 0.04*	18 \pm 1
EAFMR	143 \pm 3	3.30 \pm 0.02	0.87 \pm 0.03	23 \pm 1
HAFMR	112.0 \pm 0.5	3.11 \pm 0.04	1.72 \pm 0.02	29 \pm 2
MFMR	96.9 \pm 0.4	3.05 \pm 0.01	1.67 \pm 0.03	1.1 \pm 0.3*
HFMR	29.2 \pm 0.3	59 \pm 1*	0.12 \pm 0.01*	16 \pm 1
Gallic acid	-	1.45 \pm 0.01	1.08 \pm 0.04	-
Trolox	-	-	-	21 \pm 2

EEMR: Ethanolic extract of *M. rufula* stem bark. EAFMR: Ethyl acetate fraction of *M. rufula* stem bark. HAFMR: Hydroalcoholic fraction of *M. rufula* stem bark. MFMR: Methanolic fraction of *M. rufula* stem bark. HFMR: Hexanic fraction of *M. rufula* stem bark. Values represent the mean \pm standard deviation based on triplicate measurements. * $p < 0.05$, when compared with gallic acid ($\bullet\text{DPPH}$ e ABTS \bullet^+) and trolox (β -carotene/linoleic acid) by ANOVA and Dunnett's post-test.

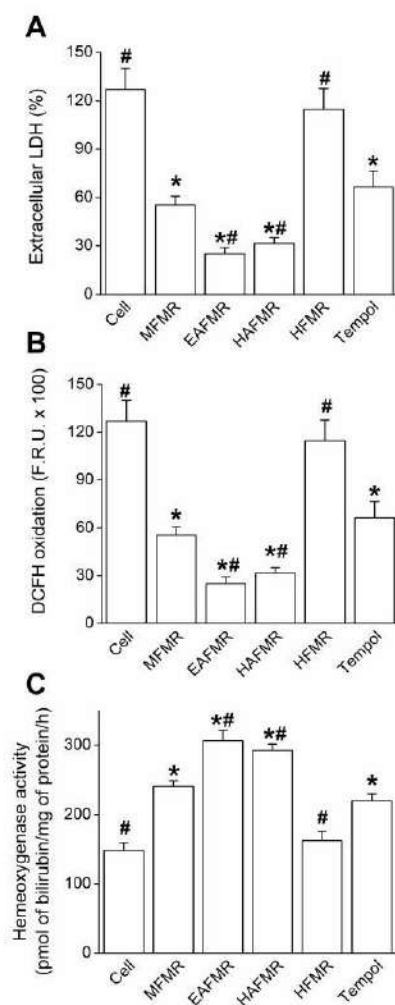


Fig. 1 Effects of *M. rufula* fractions on H_2O_2 -induced death (A), antioxidant profile (B) and hemeoxygenase activity (C) in THP-1-derived macrophages. Ethyl acetate fraction of the stem bark of *M. rufula* (EAFMR), hydroalcoholic fraction of the stem bark of *M. rufula* (HAFMR), methanolic fraction of the stem bark of *M. rufula* (MFMR) and hexane fraction of the stem bark of *M. rufula* (HFMR) at $50 \mu\text{g/mL}$ were pre-incubated with cells for 24 h. The cell viability was determined by releasing of lactate dehydrogenase to supernatant after H_2O_2 (1 mM) incubation, where Triton X-100 (1%) was used as control of a complete cell death (100%) (A). The intracellular antioxidant status was followed by DCFH oxidation in presence of H_2O_2 ($100 \mu\text{M}$) (B). The bilirubin levels were indicative of hemeoxygenase activity in the cells (C). Tempol ($10 \mu\text{M}$) was used as positive control in all assays. * $p < 0.05$ and # $p < 0.05$, when compared to cell and methanolic fraction, respectively, by ANOVA and Dunnett's post-test.

T. Antibacterial activity

Extract and fractions of the stem bark of *M. rufula* were evaluated for antibacterial potential against gram positive (*S. aureus*) and negative (*P. mirabilis*, *P. aeruginosa*, *E. coli* and *K. pneumoniae*) bacteria (Table 2). EEMR and HFMR did not present any antibacterial activity against the bacteria tested at concentrations up to 1 mg mL^{-1} . EAFMR was active against *K. pneumoniae* (MIC = 100 and CBM = $500 \mu\text{g mL}^{-1}$), *S. aureus* (MIC = CBM =

$500 \mu\text{g mL}^{-1}$) and *E. coli* (MIC = 500 = CBM = $500 \mu\text{g mL}^{-1}$). On the other hand, MFMR acted similarly on *K. pneumoniae* and *E. coli* (MIC = CBM = $50 \mu\text{g mL}^{-1}$), being the most active fraction and still with bactericidal profile (CBM/MIC ≤ 4), according to established by French et al. (2006).

Table 2. Minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) values of the *M. rufula* stem bark and fractions.

Bacterial strain	EEMR		EAFMR		HAFMR		MFMR		HFMR	
	MIC	MBC	MIC	MBC	MIC	MBC	MIC	MBC	MIC	MBC
<i>S. aureus</i>	a	a	500	500	a	a	a	a	a	a
<i>K. pneumoniae</i>	a	a	100	500	a	a	50	50	a	a
<i>P. aeruginosa</i>	a	a	a	a	a	a	a	a	a	a
<i>E. coli</i>			500	500			50	50		
<i>P. mirabilis</i>	a	a	a	a	a	a	a	a	a	a

EEMR: Ethanolic extract of *M. rufula* stem bark. EAFMR: Ethyl acetate fraction of *M. rufula* stem bark. HAFMR: Hydroalcoholic fraction of *M. rufula* stem bark. MFMR: Methanolic fraction of *M. rufula* stem bark. HFMR: Hexanic fraction of *M. rufula* stem bark. (a): Values ≥ 1000 $\mu\text{g/mL}$.

U. Antiproliferative activity to cancer cells

The antiproliferative activity of the ethanolic extract of *M. rufula* on HepG2 (human hepatocellular carcinoma) and HL-60 (human promyelocytic leukemia) cancer cells was investigated. The extract at the concentration of 50 $\mu\text{g/mL}$ showed weak antiproliferative activity on both cell lines (14.2 and 17.9%, respectively), when compared to doxorubicin (90.3 and 95.0%, respectively).

V. In vitro inhibition of *L. amazonensis* arginase

Extract and fractions of *M. rufula* were also evaluated for the ability to inhibit the enzyme arginase of *Leishmania amazonensis*. The ethanolic extract and the ethyl acetate fraction had the lowest IC_{50} values (15.7 and 15.6 $\mu\text{g mL}^{-1}$, respectively) (Table 3). Quercetin, used as a positive control, inhibited the enzyme with an IC_{50} of 1.0 $\mu\text{g mL}^{-1}$. Furthermore, there were no correlation between phenolic compounds and *L. amazonensis* arginase inhibition ($r = -0.446$ and $p = 0.451$).

Table 3. Inhibition of *L. amazonensis* arginase by *M. rufula* stem bark and fractions.

Samples	IC_{50} ($\mu\text{g mL}^{-1}$)
EEMR	15.7 \pm 1.0*
EAFMR	15.6 \pm 1.1*
HAFMR	29.4 \pm 1.4*
MFMR	26.1 \pm 1.*
HFMR	>100.0*
Quercetin	1.0 \pm 0.1

EEMR: Ethanolic extract of *M. rufula* stem bark. EAFMR: Ethyl acetate fraction of *M. rufula* stem bark. HAFMR: Hydroalcoholic fraction of *M. rufula* stem bark. MFMR: Methanolic fraction of *M. rufula* stem bark. HFMR: Hexanic fraction of *M. rufula* stem bark. Values represent the mean \pm standard deviation based on triplicate measurements. * $p < 0.05$, when compared with quercetin by ANOVA and Dunnett's post-test.

W. Anti-*L. amazonensis* and *T. cruzi* activities

In macrophages infected with *L. amazonensis* amastigotes, the ethanolic extract and the hexanic fraction reduced the infectivity index of the parasite to 4.1% and 6.9%, respectively (Table 4). MFMR, HAFMR and EAFMR, however, reduced the infectivity of *L. amazonensis* amastigotes to 21.4, 24.4 and 19.5%, respectively. Additionally, the extract and fractions of *M. rufula* were evaluated for *in vitro* trypanocidal potential. Murine macrophages infected with *T. cruzi* and treated

with EAFMR, MFMR, HAFMR and HFMR had the infectivity index reduced by 78.1, 53.9, 54.9, and 10.5%, respectively (Table 4). There was no association between the effect observed on *L. amazonensis* amastigotes and the phenolic concentration in the samples ($r = 0.862$ and $p = 0.060$). On the other hand, a positive correlation between the concentration of reducing compounds in the samples with the trypanocidal activity was found ($r = 0.972$ and $p = 0.006$).

Table 4. Leishmanicidal and trypanocidal activities of the *M. rufula* stem bark and fractions.

Samples	Inhibition of infectivity index (%)	
	<i>L. amazonensis</i>	<i>T. cruzi</i>
EEMR	4.1	n.a.
	0.1-8.1	
EAFMR	19.5	78.1*
	18.5-20.4	76.2-77.6
MFMR	21.4	53.9*
	21.0-21.7	46.9-60.2
HAFMR	24.4*	54.9*
	17.7-31.0	51.3-60.7
HFMR	6.9	10.5
	4.6-9.1	6.8-13.0
Amphotericin B	1.67	-
	1.65-1.70	
Benznidazole	-	0.55
		0.60 – 0.51

EEMR: Ethanolic extract of *M. rufula* stem bark. EAFMR: Ethyl acetate fraction of *M. rufula* stem bark. HAFMR: Hydroalcoholic fraction of *M. rufula* stem bark. MFMR: Methanolic fraction of *M. rufula* stem bark. HFMR: Hexanic fraction of *M. rufula* stem bark. (n.a.):No activity. The values represent the mean and the values of the replicates of the experiment. The data were expressed as a function of the reduction of the infectivity index of the parasite in comparison of control. The concentration of the sample was 20 or 100 µg/mL for the tests with *L. amazonensis* or *T. Cruzi* amastigotes, respectively.

X. Qualitative analysis of phytochemicals

The phytochemical profile of the stem bark of *M. rufula* was initially analyzed for the presence of triterpenes, alkaloids and flavonoids by some classical phytochemical methods. The assay did not demonstrate the presence of these compounds in the samples, except for HFMR, whose qualitative Liebermann-Burchard test indicated the presence of triterpenes. Recognizing the limitations of these methods (Simões et al., 1999), plant extract and fractions were also analyzed by infrared technique to identify which functional groups were present and to correlate them with groups common to the Sapotaceae family, followed by LC-MS/MS and GC-MS analysis.

Y. Infrared spectroscopy

The IR spectrum (Table 5 and Fig. 2) of the HFMR fraction showed a profile of CH₃- and CH₂-rich compounds which along with C=O and C-O bands of esters indicate the presence of fatty esters and/or terpenes, common compounds in low polarity fractions of plant extracts. The infrared analysis does not allow the distinction between the groups above mentioned. However, considering the qualitative analysis, it can be

stated that HFMR has triterpenes. In the EAFMR fraction, a relative decrease in the intensity of the bands related to fatty esters was observed. In contrast, there was a strong band of O-H groups present in phenols or alcohols, besides the presence of numerous C-O binding bands at 1020 to 1200 cm⁻¹, indicating the presence of glycosidic groups. On the other hand, the analysis of the spectra allowed to conclude that the chemical profile of the constituents present in the HAFMR fraction was similar to the constituents of the MFMR fraction, being observed an intense band corresponding to O-H groups, which is in agreement with the greater polarity of these fractions, but absence of compounds with C=O groups of esters and ketones. Furthermore, it was found that both fractions had a large number of C-O stretching bands, indicating the presence of glycosidic groups, as well as a band of carbonyl conjugated to aromatic rings, common in classes of compounds such as flavones or aromatic acids (Barbosa, 2013).

Table 5. Infrared analysis of the *M. rufula* stem bark and fractions.

Wave n° (cm ⁻¹)	Functional group	EEMR	EAFMR	HAFMR	HFMR	MFMR
3328,8	vO-H (Alcohol or Phenol)	XXX	XXX	XXX	-	XXX

3000-2800	$\nu_{C_{sp^3}-H}$	XXX	XX	XX	XXX	XX
1733.9	$\nu_{C=O}$ (ester)	X	X	-	XX	-
1606.3	$\nu_{C=O}$ conjugated with aromatic	XX	XX	XXX	-	XX
1516	$\nu_{C=C}$ (alkene or aromatic ring)	X	X	X	-	X
1440 – 1480	δ_{CH_2}	X	XX	XX	XX	XX
1370 – 1390	δ_{CH_3}	X	-	X	XX	X
1243.3	ν_{C-O} (phenol)	X	XX	X	XX	X
1020 – 1200	ν_{C-O} (alcohol)	XX	XX	XX	X	XX
700 – 850	C-H (aromatic ring)	-	X	X	-	X

EEMR: Ethanolic extract of *M. rufula* stem bark. EAFMR: Ethyl acetate fraction of *M. rufula* stem bark. HAFMR: Hydroalcoholic fraction of *M. rufula* stem bark. MFMR: Methanolic fraction of *M. rufula* stem bark. HFMR: Hexanic fraction of *M. rufula* stem bark. (-): Absence of band in the spectrum. (X): Small band intensity in the spectrum. (XX): Medium band intensity in the spectrum. (XXX): High band intensity in the spectrum.

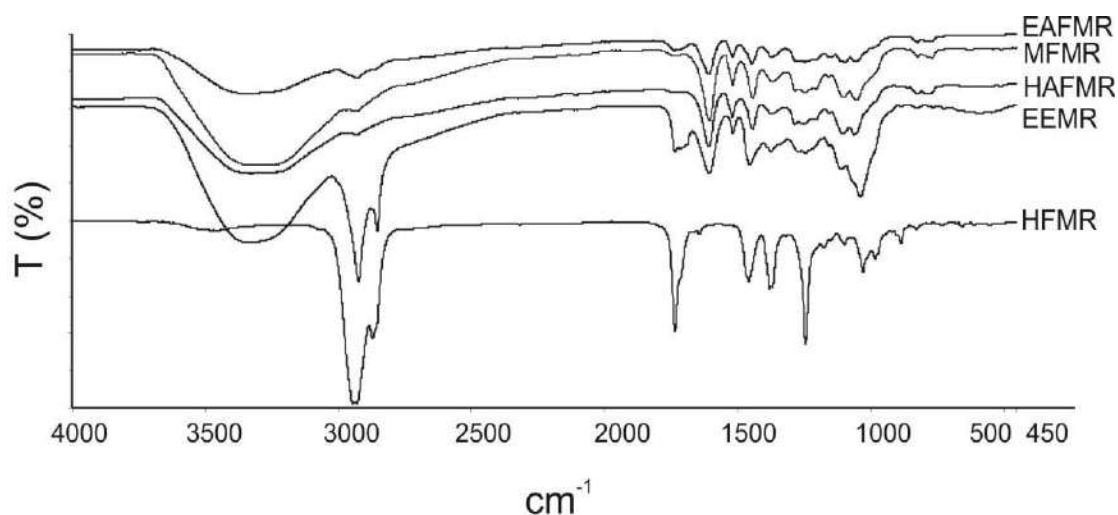


Fig. 2 Infrared spectrum of extract and fractions of the stem bark of *M. rufula*. EEMR: Ethanolic extract from the stem bark of *M. rufula*. EAFMR: Ethyl acetate fraction of the stem bark of *M. rufula*. HAFMR: Hydroalcoholic fraction of the stem bark of *M. rufula*. MFMR: Methanolic fraction of the stem bark of *M. rufula*. HFMR: Hexanic fraction of the stem bark of *M. rufula*.

Z. LC-MS/MS analysis

The methanolic, hydroalcoholic and ethyl acetate fractions of the *M. rufula* stem bark were analyzed in the sequence, by negative ionization mass spectrometry. The ions m/z 577 and 865 were found in the EAFMR and HAFMR fractions (Table 6). The comparison of m/z values and their respective fragments with the literature indicated the presence of proanthocyanidin dimers (Bystrom et al., 2008). Proanthocyanidin trimers (m/z 865.28 and 865.33) were also potentially found in the EAFMR and HAFMR fractions (Simões et al., 1999, Barbosa, 2013). Ions 289 and 577 also suggested the presence of proanthocyanidin subtypes as catechin in ethyl acetate and hydroalcoholic

fractions, whereas the 341 ion was possibly the glycoside caffeoyl glucose present in the MFMR fraction (Bastos et al., 2007).

The EAFMR, HAFMR and MFMR fractions presented the ions 757 and 367, whose fragmentation did not allow the identification of the potential compound, but the literature suggests them as quercetin-3-O-triglycoside and feruloylquinic acid (Chen et al., 2012). Besides, the nature of several other ions and their fragments has not been suggested, which demonstrates the importance of further studies in order to reliably isolate and identify these compounds.

Table 6. Retention times and fragments of the major ions found in the *M. rufula* stem bark by LC-MS/MS in the negative mode.

Sample	Retention time (min)	[M-H] ⁻	Fragments	Putative substances
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EAFMR	14.4	577	289; 425	Proantocyanidin dimer
	15.5	865	287;695;739	Proantocyanidin trimer
	15.5	289	205; 245	Catechin
HAFMR	18.1	577	289;425	Proantocyanidin dimer
	14.4	577	289;425	Proantocyanidin dimer
MFMR	15.7	865	695;739	Proantocyanidin trimer
	3.8	341	179	Caffeoil glucose

EAFMR: Ethyl acetate fraction of *M. rufula* stem bark. HAFMR: Hydroalcoholic fraction of *M. rufula* stem bark. MFMR: Methanolic fraction of *M. rufula* stem bark.

AA. CG-MS analysis

Finally, the HFMR fraction was analyzed by gas chromatography coupled to mass spectrometry, which detected the presence of olean-12-en-3-one, lanosta-8,24-dien-3-one, lupenone, lupeol acetate, cycloheucalenol acetate, cyclolanostan-3-ol, cis-3,14-clerodadien-13-ol, by comparison with the NIST library and similarity of 92, 76, 89, 87, 76, 85 and 79%. The chemical structure of the compounds identified in the HFMR is shown in Fig. 3.

IV. DISCUSSION

Species of the genus *Manilkara* are known to contain flavonoids, phenolic acids, saponins and triterpenes, which are associated with pharmacological properties, including anti-inflammatory, antiparasitic, antitumor, antibacterial and antioxidant properties (Ma et al., 2003; Eibonde et al., 2004; Eskander et al., 2014). Among the different metabolites, phenolic compounds are important due to their inherent antioxidant potential, being able to reduce damage to the host tissue during inflammatory and/or oxidative processes typical of several chronic diseases such as cancer, arthritis, diabetes, atherosclerosis, among others (Fernandes, 2010; Parick and Patel, 2016). Thus, concentrations of phenolics and other reducers in all samples of the stem bark of *M. rufula* were determined, and the concentrations found here are higher than those in the study of Parikh and Patel (2016) from the methanolic extract of the fruit of *Manilkara hexandra* (8.1 µg EAG/mg). It is noteworthy that the AEFMR fraction presented higher phenolic concentration in relation to the HFMR fraction likely because most of reducing compounds are more polar (Andreo and Jorge, 2006).

As for the antioxidant activity, it was possible to observe that all the samples were able to deactivate the •DPPH and ABTS•+ radicals and to inhibit the oxidation of β-carotene by the lipid radicals. Although studies demonstrating the antioxidant activity of *M. rufula* are missing, investigations with *Sideroxylon obtusifolium* from

same family as *M. rufula* have shown that the ethanolic extract of this plant reduces the •DPPH radical with IC₅₀ of 9.5 µg/mL, indicating a similar antioxidant activity between these two species (Leite et al., 2015). The fractions of *M. rufula* probably contain molecules with cytoprotective activity, particularly the ethyl acetate fraction that protected the cells against death induced by H₂O₂ in approximately 83%. This same fraction also inhibited intracellular redox stress more significantly than tempol, a well recognized antioxidant in several *in vitro* and *in vivo* models (Soule et al., 2007). The ethyl acetate fraction may protect the macrophages against H₂O₂-induced damage through Nuclear factor (erythroid-derived 2)-like 2 (Nrf2) pathway, which is an important transcription factor for many antioxidant and cytoprotective enzymes, including hemeoxygenase. A recent study with *Madhuca indica* from Sapotaceae family showed that the compound 3,5,7,3',4'-pentahydroxyflavone was cytoprotective by inducing the expression of antioxidant enzymes related to Nrf2-Keap1 system (Wang et al., 2010). Indeed, Nrf2 signaling pathway may be activated by several phytochemicals, including polyphenols and triterpenoids, which could explain the effects mediated by *M. rufula* on macrophages (Park et al., 2007; Facundo et al., 2005). An intriguing point is that all the samples of *M. rufula* showed considerable toxicity against THP-1-derived macrophages up to the concentration of 100 µg/mL. In the literature, the ethyl acetate fraction of *Pouteria venosa* (Sapotaceae) plant showed no toxicity on macrophages of the J774 lineage at the concentration of 200 µg/mL, which is in agreement with our results (Santos et al., 2015). Therefore, these preliminary data suggest that this plant possibly has low toxicity for application in *in vivo* models.

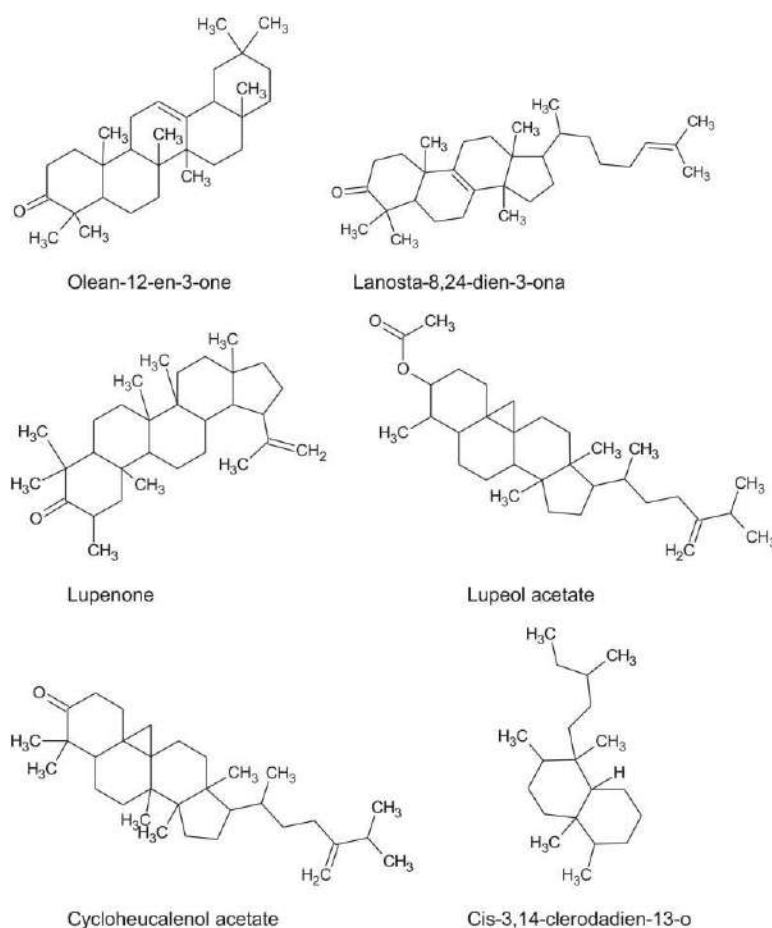


Fig. 3 Chemical structure of the compounds found in the hexane fraction of the stem bark of *M. rufula* by CG-MS.

Scientific and ethnopharmacological studies have also reported the use of Sapotaceae plants in the treatment of cancer (Bhaumik et al., 2015). Nevertheless, the EEMR showed only weak antiproliferative activity on HepG2 and HL-60 cell lines. The ability of some constituents from this plant in activating the Nrf2 pathway may justify, at least in part, its low toxicity against cancer cells (Chen et al., 2015).

Sapotaceae also contains plant species to which antiprotozoal activity has been reported, including against *Trypanosoma*, *Plasmodium* and *Trichomonas vaginalis* (Vieira et al., 2016; Silva et al., 2013; Innocente et al., 2014). Arginase stands out among the possible targets in trypanosomatids because this enzyme catalyzes the hydrolysis of L-arginine to L-ornithine and urea in trypanosomatids like *Leishmania* sp. and *T. brucei*, but not in *T. cruzi*. Ornithine is a precursor of the polyamines pathway and therefore involved in mechanisms related to cell proliferation and survival, constituting an important target for the treatment of parasites such as leishmaniasis (Birkholtz et al., 2011; Cruz et al., 2013). Mammals also have two arginase isoforms but they contain two non-conserved amino acids that creates distinct channel like

domains in comparison to trypanosomatids, which allows the development of specific inhibitors (Riley et al., 2011).

Extract and fractions of *M. rufula* were evaluated for the ability to inhibit the arginase of *Leishmania amazonensis*. EEMR and EAFMR presented the lowest IC₅₀ values (15.7 and 15.6 µg mL⁻¹, respectively). A study that aimed the anti-arginase activity by extract of the medicinal plant *Cecropia pachystachya* had IC₅₀ 17 µg mL⁻¹ (Cruz et al., 2013). Isolated polyphenols as (+)-catechin and (-)-epicatechin that are monomeric unit of proanthocyanidin present in the fractions EAFMR, HAFMR, showed a great arginase inhibition (dos Reis et al., 2013; de Souza et al., 2014). The caffeoyl glucose present at MFMR fraction contributed to the *L. amazonensis* arginase inhibition as observed by activity of verbascoside, a compound that containing caffeoyl moiety as pharmacophoric group (Maquiaveli et al., 2016). In fact, antileishmanial verbascoside target selectively parasite arginase (Maquiaveli et al., 2017). Verbascoside also is a major compound present in *Stachytarpheta cayennensis* traditional medicinal plant used to treat leishmaniasis (Maquiaveli et al., 2016).

In the case of macrophages infected with *L. amazonensis* amastigotes, the MFMR, HAFMR and EAFMR fractions reduced the infectivity of *L. amazonensis* amastigotes more sharply, which leads us to infer that these fractions act on other targets associated with the survival of *L. amazonensis* (Singh et al., 2012). In contrast, it was observed that EEMR inhibited arginase *in vitro*, but did not reduce the infectivity of *Leishmania* in a cellular model, which could be due to lower permeability of phytochemicals through the membranes or to metabolism of these compounds by the parasite/macrophage (Silva et al., 2012). Moreover, there was no association between the effect observed on *L. amazonensis* amastigotes and the phenolic concentration in the samples, which indicates that other compounds must be responsible for the leishmanicidal activity. The IC₅₀ of arginase inhibition by fraction EAFMR, MFMR, HAFMR are closed related to the reduction of infectivity index of *L. amazonensis* amastigotes showed in this study. These data are an evidence of the extract and fractions kill *L. amazonensis* targeting parasite arginase. Nevertheless, the development of therapeutic strategies based on antioxidants sources should take into account the potential risk of altering host resistance to parasite infection and worsening the infection (Silva and Castilhos, 2015).

Regarding the *in vitro* trypanocidal activity, all fractions significantly reduced *T. cruzi* infection (10.5 to 78.1%). There are no specific studies on the leishmanicidal and trypanocidal activities of *M. rufula* in the literature. However, a study demonstrated the trichomonocidal effect of the dichloromethane extract of leaves and branches of this plant (Vieira et al., 2016). The aqueous extract from the leaves of *P. ramiflora* (Sapotaceae) was able to induce the death of promastigote forms of *Leishmania amazonensis* *in vitro* (Linares et al., 2008). Cruz et al. (2010) found that a flavonoid glycoside present in leaf of *Cecropia pachystachya* (Cecropiaceae) altered the mitochondrial DNA of *L. amazonensis*, besides inhibiting the enzyme arginase, and thus preventing the development of this parasite. In addition, the triterpenoids isolated from the dichloromethane extract of the fruit pericarp of *Omphalocarpum procerum* (Sapotaceae) led to the death of *T. cruzi*, *L. donovani*, *P. falciparum* and *T. brucei rhodesiense* in different cell models (Ngamwee et al., 2014).

The present study indicated the presence of several types of terpenes, such as proanthocyanidins, in *M. rufula* from Maracás, Bahia, Brazil. Previous studies with *M. zapota* and *M. rufula* had isolated several types of proanthocyanidins, which is in agreement with the present

findings (Wang et al., 2010). Based on these preliminary results, the pharmacological activities described for *M. rufula* can be explained by the presence of proanthocyanidins, as they are widely known in the literature because of their biological activities such as anti-inflammatory, anticancer, antibacterial, antifungal, antiviral, antiparasitic activity, inhibition of platelet aggregation and cytoprotective (Augustin et al., 2011; Trentin et al., 2013). However, this can only be affirmed after isolation of *M. rufula* metabolites for reliable identification of plant components.

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REFERENCES

- [1] N.Y.M. Kuera, J.A. Lopez, E.L. Little Jr., G.F. Ritz., J.S. Rombold, W.J. Hahn. "Arboles Comues Del Paraguay", Cuerpo de Paz, Colección e Intercambio de Información, vol 2, pp. 458, 2002.
- [2] V. Araújo Neto. Study of the antinociceptive, anti-inflammatory and antioxidante activities of *Sideroxylon obtusifolium* (Sapotaceae). Sergipe: UFS, Dissertação de Mestrado em Biotecnologia, pp. 61, 2009.
- [3] I.G. Gomes, A.F. Calabrich, R.S. Tavares, J. Wietzerbin, L.A. de Freitas, P.S. Veras. "Differential properties of CBA/J mononuclear phagocytes recovered from an inflammatory site and probed with two different species of *Leishmania*", *Microbes Infect.*, vol 5, pp. 251-260, 2003.
- [4] J. Ma, X. Luo, P. Protiva, H. Yang, C. Ma, M.I. Basile, et al. "Bioactive novel polyphenols from the fruit of *Manilkara zapota*", *J Nat Prod.*, vol 66, pp. 983-986, 2003.
- [5] L.S. Eibond, K.A. Reynertson, X.D. Luo, M.J. Basile, E.J. Kennelly. "Anthocyanin antioxidants from edible fruits", *Food Chem.*, vol 84, pp. 23, 2004.
- [6] P.B. Vieira, N.L.F. Silva, G.N.F. Silva, D.B. Silva, N.P. Lopes, et al. "Caatinga plants: Natural and semi-synthetic compounds potentially active against *Trichomonas vaginalis*", *Bioorg. Med. Chem. Lett.*, vol 26, pp. 2229-2236, 2016.
- [7] R.M. de Souza. Atividade antioxidante e antimicrobiana de plantas da caatinga. Recife: Universidade Federal de Pernambuco. Tese de Doutorado no Programa de Pós-Graduação em Ciências Biológicas. 2015. p. 106.

- [8] K.N. Kuroshima. Estudos químicos e farmacológicos das plantas *Virola oleifera* e *Hyeronima alchrneoides*. Florianópolis: Universidade Estadual de Santa Catarina. Tese de Doutorado em Química.2002; p.104.
- [9] C.V. Silva, F.C.C. Bomfim, M.A.V. Dos Santos, E.S. Velozo. “Estudo fitoquímico e avaliação in vitro da atividade anti-*Trypanosoma cruzi* cepa Y de *Pilocarpus spicatus* St. Hil.(Rutaceae)”, Rev. Bras. Pl. Med., vol 4, pp. 812-818, 2014.
- [10] V.L. Singleton, R. Orthofer, R.M. Lamuela. “Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent”, Methods enzyme, vol 299, pp. 152-178, 1992.
- [11] H. Wagner, S. Blad. Plant Drug Analysis: a thin layer chromatography atlas. 2 ed. (reprint). Springer. 2009. p. 197.
- [12] F.J. Matos. Introdução à fitoquímica experimental. 2.ed. Fortaleza: Edições UFC. 1997. 141p.
- [13] C.F.C. Ruschel, C.T. Huang, D. Samios, M.F. Ferrão. “Análise exploratória aplicada a espectros de reflexão total atenuada no infravermelho com transformada de fourier (atr-ftir) de blendas de biodiesel/diesel”, Quim. Nova, vol 37, pp. 810-815, 2014.
- [14] G.J. Marco. “A rapid method for evaluation of antioxidants”, J Am Oil Chem Soc., vol 45, pp. 594-598, 1968.
- [15] H.E. Miller. “A simplified method for the evaluation of antioxidant”, J Am Oil Chem Soc., pp. 48-91, 1971.
- [16] E.K. Park, H.S. Jung, H.I. Yang, M.C. Yoo, C. Kim, K.S. Kim. “Optimized THP-1 differentiation is required for the detection of responses to weak stimuli”, Inflamm Res., vol 1, pp. 45-50, 2007.
- [17] H.T. Facundo, J.G. De Paula, A.J. Kowaltowski. “Mitochondrial ATP-sensitive K⁺ channels prevent oxidative stress, permeability transition and cell death”, J Bioenerg Biomembr., vol 37, pp. 75-82, 2005.
- [18] S.O. Jeong, G.S. Oh, H.Y. Ha, B. Soon Koo, H. Sung Kim, Y.C. Kim, et al. “Dimethoxycurcumin, a Synthetic Curcumin Analogue, Induces Heme Oxygenase-1 Expression through Nrf2 Activation in RAW264.7 Macrophages”, J Clin Biochem Nutr., vol 44, pp. 79-84, 2009.
- [19] J.R. Pereira, R.F. Queiroz, E.A. Siqueira, C.B. Vidal, A.E.G. Santana, D.M. Silva, P.R.A.M. Affonso. “Evaluation of cytogenotoxicity, antioxidant and hypoglycemic activities of isolate compounds from *Mansoa hirsuta* D.C. (Bignoniaceae)”, An Acad Bras Cien (Impresso) (No prelo). 2017.
- [20] T.L.A. Santos, R.F. Queiroz, A.C.H.F. Sawaya, B.G. Lopez, M.B.P. Soares, D.P. Bezerra, et al. “*Melipona mondury* produces a geopropolis with antioxidant, antibacterial and antiproliferative activities”, An Acad Bras Cien (Impresso) (No prelo). 2017.
- [21] A.S. Ahmed, R.M. Gogal, J.E. Walsh. “A new rapid and simple non-radioactive assay to monitor and determine the proliferation of lymphocytes an alternative to [3H] thymidine incorporation assay”, J Immunol Methods, vol 170, pp. 211-224, 1994.
- [22] A.C. Rodrigues, L.M. Bomfim, S.P. Neves, L.R.A. Menezes, R.B. Dias, M.B. Soares, et al. “Antitumor properties of the essential oil from the leaves of *Duguetia Gardneriana*”, Planta Med., vol 81, pp. 798-803, 2015.
- [23] E.R. da Silva, M.F.L. da Silva, H. Fischer, R.A. Mortara, M.G. Mayer, K. Framesqui, et al. “Biochemical and biophysical properties of a highly active recombinant arginase from *Leishmania (Leishmania) amazonensis* and subcellular localization of native enzyme”, Molecular Biochem Parasitol., vol 159, pp. 104-111, 2008.
- [24] E.R. da Silva, C.C. Maquiaveli, P.P. Magalhães. “The leishmanicidal flavonols quercetin and quercitrin target *Leishmania (Leishmania) amazonensis* arginase”, Exp Parasitol., vol 130, pp. 183-188, 2012.
- [25] J.K. Fawcett, J.E. Scott. “A rapid and precise method for the determination of urea”, J Clin Pathol., vol 13, pp. 156-159, 1960.
- [26] L.C. Manjolin, E.R. Da Silva, M.B.G. Reis, C.C. Maquiaveli, A.O. Santos-Filho. “Dietary flavonoids fisetin, luteolin and their derived compounds inhibit arginase, a central enzyme in *Leishmania (Leishmania) amazonensis* infection”, Food Chem., vol 141, pp. 2253-2262, 2013.
- [27] S.P. Chaves, E.C. Torres-Santos, C. Marques, V.R. Figliuolo, P.M. Persechini, R. Coutinho-Silva, et al. “Modulation of P2X₇ purinergic receptor in macrophages by *Leishmania amazonensis* and its role in parasite elimination”, Microbes Infect., vol 11, pp. 842-849, 2009.
- [28] A.K. Tanaka, V.B. Valera, H.K. Takahashi, A.H. Straus. “*Leishmania amazonensis* growth and infectivity by aureobasidin A”, Journal of Antimicrobial Chemotherapy, vol 59, pp. 487-492, 2007.
- [29] T.M. Bastos. Avaliação da atividade Anti-*Trypanosoma cruzi* de nitrosilo/nitro complexos de rutênio em modelos experimentais in vitro e in vivo. Feira de Santana: Universidade Estadual de Feira de Santana. Dissertação de Mestrado no Programa de Pós-Graduação em Biotecnologia. 2013. p. 73.
- [30] G.L. French. “Bactericidal agents in the treatment of MRSA infections- the potential role of daptomycin”, J Antimicrob Chemother, vol 58, pp. 1107-1117, 2006.
- [31] O.M.C. Simões, R.P. Schenkel, G. Gosmann, P.C.J. Mello, A.L. Mentz, P.R. Petrovick. Farmacognosia da planta medicamento. Editora da Universidade Federal do Rio Grande do Sul. 1999.
- [32] L.C.A. Barbosa. Espectroscopia no Infravermelho na caracterização de compostos orgânicos. Editora UFV, Viçosa. 2013. vol. 1, n.1, p. 189.
- [33] L.M. Bystrom, B.A. Lewis, D.L. Brown, E. Rodriguez, R.L. Obendorf. “Characterization of phenolics by LC-UV/vis, LC-MS/MS and sugars by GC in *Melicoccus bijugatus* Jacq. ‘Montgomery’ fruits”, Food Chem, vol 111, pp. 1017-1024, 2008.

- [34] D.H.M. Bastos, L.A. Saldanha, R.R. Catharino, A.C.H.F. Sawaya, I.B.S. Cunha, P.O. Carvalho; et al. "Phenolic Antioxidants Identified by ESI-MS from *Yerba Maté* (*Ilex paraguariensis*) and *Green Tea* (*Camelia sinensis*) Extracts", *Molecules*, vol 12, pp. 423-432, 2007.
- [35] H. Chen, B.S. Inbaraj, B. Chen. "Determination of Phenolic Acids and Flavonoids in *Taraxacum formosanum* Kitam by Liquid Chromatography-Tandem Mass Spectrometry Coupled with a Post-Column Derivatization Technique", *Int J Mol Sci.*, vol 13, pp. 260-285, 2012.
- [36] J.Y. Eskander, E.G. Haggag, M.R. El-Gindi, M.M. Mohamed. "A novel saponin from *Manilkara hexandra* seeds and anti-inflammatory activity", *Med Chem Res.*, vol 23, pp. 717-724, 2014.
- [37] A.S.F. Fernandes. Propriedades nutricionais, nutraceuticas e antioxidantes de espécies silvestres condimentares utilizadas na gastronomia tradicional do nordeste transmontano. Bragança-SP. Dissertação de Mestrado em Qualidade e Segurança Alimentar. 2010. p. 63.
- [38] B. Parick, V.H. Patel. "Quantification of phenolic compounds and antioxidant capacity of an underutilized Indian fruit: Rayan [*Manilkara hexandra* (Roxb.) Dubard]", *Food Sci. Hum. Wellness*, 2016.
- [39] D. Andreo, N. Jorge. "Antioxidantes naturais: técnicas de extração", *Boletim do Centro de Pesquisa de Processamento de Alimentos*, vol 24, pp. 319-326, 2006.
- [40] N.S. Leite, A.P. Lima, V. Araújo-Neto, C.S. Estevam, S.M. Pantaleão, E.A. Camargo, et al. "Avaliação das atividades cicatrizante, anti-inflamatória tópica e antioxidante do extrato etanólico da *Sideroxylon obtusifolium* (quixabeira)", *Rev. Bras. Pl. Med.*, vol 17, pp. 164-170, 2015.
- [41] B.P. Soule, F. Hyodo, K. Matsumoto, N.L. Simone, J.A. Cook, M.C. Krishna, et al. "The chemistry and biology of nitroxide compounds", *Free Rad. Bio. Med.*, vol 42, pp. 1632-1650, 2007.
- [42] X. Wang, R. Liu, X. Ye; C. Hay. "Antioxidant activities of oleanolic acid in vitro: Possible role of Nrf2 and MAP kinases", *Chemico-biological interactions*, vol. 3, pp. 328-37, 2010.
- [43] R.F.E.P. Santos, I.S.M. Silva, R.C.S.S. Veríssimo, I.M.L. Lúcio, E.A. Campesatto, L.M. Conserva, et al. "Estudo do potencial antimicrobiano e citotóxico da espécie *Pouteria venosa* (Sapotaceae)", *Rev. Bras. Pl. Med.*, vol 17, pp. 367-373, 2015.
- [44] A. Casadevall. "Antibody-based therapies for emerging infectious diseases", *Emerg Infect Dis.*, vol 3, pp. 200-208, 1996.
- [45] C.P.L. Sampaio, I.M. Dias, F.M. Faria, M.V.M. Oliveira. "Principais bactérias causadoras de infecção hospitalar", *Rev Dig Buenos Aires*, vol 10, p. 182, 2013.
- [46] H. Von Baum, R. Marre. "Antimicrobial resistance of *Escherichia coli* and therapeutic implications", *Internat. Journ. of Med. Microb.*, vol 295, pp. 503-511, 2005.
- [47] E.A.P. Figueiredo, H. Ramos, M.A.V. Maciel, M.C.M. Vilar, N.G. Loureiro, R.G. Pereira. "*Pseudomonas Aeruginosa*: Frequência de Resistência a Múltiplos Fármacos e Resistência Cruzada entre Antimicrobianos no Recife/PE", *Rev Bras Terapia Intensiva*, vol 19, pp. 421-427, 2007.
- [48] A.L. Santos, D.O. Santos, C.C. Freitas, B.L.A. Ferreira, I.F. Afonso, C.R. Rodrigues, et al. "*Staphylococcus aureus*: visitando uma cepa de importância hospitalar", *Journal Bras Patol Med Lab.*, vol 43, pp. 413-423, 2007.
- [49] R. Nair, S. Chanda. "Antimicrobial Activity of *Terminalia catappa*, *Manilkara zapota* and *Piper betel* Leaf Extract", *Indian J Pharm Sci.*, vol 3, pp. 390-393, 2008.
- [50] F.B. Holetz, G.L. Pessini, N.R. Sanches, D.A. Cortez, C.V. Nakamura. "Screening of some plants used in the Brazilian folk medicine for the treatment of infectious diseases", *Mem I Oswaldo Cruz*, vol 97, pp. 1027-1031, 2002.
- [51] H.S. Ruela, I.C.R. Leal, M.R.A. Almeida, K.R.N. Santos, L.A. Wessjohan, R.M. Kuster. "Antibacterial and antioxidant activities and acute toxicity of *Bumelia sartorum* Mart., Sapotaceae, a Brazilian medicinal plant", *Rev. Bras Farmacogn.*, vol 21, p.1, 2011.
- [52] A. Bhaumik, U.M. Kumar, K.A. Khan, C. Srinivas. "The Bioactive Compounds Obtained from the Fruit-Seeds of *Madhuca longifolia* (L) Act as Potential Anticancer Agents", *Sch. J. App. Med. Sci.*, vol 4, pp. 1235-1238, 2014.
- [53] S. Chen, Y. Zhu, Z. Liu, Z. Gao, B. Li, D. Zhang, et al. "Grape Seed Proanthocyanidin Extract Ameliorates Diabetic Bladder Dysfunction via the Activation of the Nrf2 Pathway", *GSPE Ameliorates Diabetic Bladder Dysfunction*, vol 5, pp. 1-16, 2015.
- [54] G.N. Silva, N.R. Maria, D.C. Schuck, L.N. Cruz, M.S. De Moraes, M. Nakabashi, et al. "Two series of 78 new semisynthetic triterpene derivatives: differences in antimalarial activity, cytotoxicity and mechanism of action", *Malaria J.*, pp. 1289, 2013.
- [55] A.M. Innocente, P.B. Vieira, A.P. Frasson, B.B. Casanova, G. Gosmann, S.C. Gnoatto, et al. "Anti-*Trichomonas vaginalis* activity from triterpenoid derivatives", *Parasitol Res.*, vol 113, pp. 2933-2940, 2014.
- [56] L.M. Birkholtz, M. Williams, J. Niemand, A.I. Louw, L. Persson, O. Heby. "Polyamine homeostasis as a drug target in pathogenic protozoa: peculiarities and possibilities", *Biochem J.*, vol 2, pp. 229-244, 2011.
- [57] E.M. Cruz, E.R. Silva, C.C. Maquiaveli, E.S.S. Alves, J.R.J.F. Lucon, M.B.G. Reis, et al. "Leishmanicidal activity of *Cecropia pachystachya* flavonoids: Arginase inhibition and altered mitochondrial DNA arrangement", *Phytochemistry*, vol 89, pp. 71-77, 2013.
- [58] E. Riley, S.C. Roberts, B. Ullman. "Inhibition profile of *Leishmania Mexicana* arginase reveals differences with human arginase I", *International Journal for Parasitology*, vol 279, pp. 23668-23678, 2011.
- [59] M.B. Dos Reis, L.C. Manjolin, C.C. Maquiaveli, O.A. Santos-Filho, E.R. da Silva. "Inhibition of *Leishmania (Leishmania) amazonensis* and Rat Arginases by Green Tea EGCG, (+)-Catechin and (2)-Epicatechin: A

- Comparative Structural Analysis of Enzyme-Inhibitor Interactions”, Plos One, vol 8, pp. 783-787, 2013.
- [60] L.R.F. De Sousa, S.D. Ramalho, M.C. Burger, L. Nebo, J.B. Fenandes, M.F. Da Silva, et al. “Isolation of Arginase Inhibitors from the Bioactivity-Guided Fractionation of *Byrsonima coccolobifolia* Leaves and Stems”, Journal of Natural Products, vol 77, pp. 392-386, 2014.
- [61] C.C. Maquiaveli, A.M. Oliveira e Sá, P.C. Vieira, E.R. da Silva. “*Stachytarpheta cayennensis* extract inhibits promastigote and amastigote growth in *Leishmania amazonensis* via parasite arginase inhibition”, Journal of Ethnopharmacology, vol 192, pp. 108-113, 2016.
- [62] C.C. Maquiaveli, A.L. Rochetti, H. Fukumasu, P.C. Vieira, E.R. da Silva. “Antileishmanial activity of verbascoside: Selective arginase inhibition of intracellular amastigotes of *Leishmania (Leishmania) amazonensis* with resistance induced by LPS plus IFN- γ ”, Biochemical Pharmacology, vol 127, pp. 28-33, 2017.
- [63] N. Singh, M. Kumar, R.K. Singh. “Leishmaniasis: current status of available drugs and new potential drug targets”, Asian Pac J Trop Med, vol 6, pp. 485-497, 2012.
- [64] E.R. Silva, C.C. Maquiaveli, P.P. Magalhães. “The leishmanicidal flavonols quercetin and quercitrin target *Leishmania (Leishmania) amazonensis* arginase”, Exp Parasitol., vol 130, pp. 183-188, 2012.
- [65] N.S.L. Silva, P. Castilhos. “Efeito de dez plantas do cerrado brasileiro sobre a viabilidade de promastigotas de *Leishmania amazonensis*”, Sinergia, vol 16, pp. 269-274, 2015.
- [66] E. Linares, S. Giorgio, O. Augusto. “Inhibition of in vivo leishmanicidal mechanisms by tempol: Nitric oxide down-regulation and oxidant scavenging”, Free Radical Biology & Medicine, vol 44, pp. 1668-1676, 2008.
- [67] R.F. Ngamgwe, R. Yankam, J.R. Chouna, C. Lanz, J. Furrer, S. Schurch. “Procerenone: a Fatty Acid Triterpenoide from the Fruit Pericarp of *Omphalocarpum procerum* (Sapotaceae)”, Iran J Pharm Res., vol 4, pp. 1425-1430, 2014.
- [68] J.M. Augustin, V. Kuzina, S.B. Andersen, S. Bak. “Molecular activities, biosynthesis and evolution of triterpenoid saponins”, Phytochemistry, vol 72, pp. 435-457, 2011.
- [69] D.S. Trentin, D.B. Silva, M.W. Amaral, K.R. Zimmer, M.V. Silva, N.P. Lopes, et al. “Tannins possessing bacteriostatic effect impair *Pseudomonas aeruginosa* adhesion and biofilm formation”, PLoS One., vol 8, pp. 66257, 2013.
- [70] J.A. Marengo. “Vulnerabilidade, impactos e adaptação à mudança do clima semi-árido do Brasil”, Parc Estrat., vol 13, pp. 27, 2008.

Pleasure and Suffering at Work: Study with Current Health Professionals in Urgency Units

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Abstract— Objective: The objective of this study was to identify the factors that cause pleasure and suffering in the context of the work of health professionals who work as team coordinators in urgent and emergency care services. **Methods:** The application was performed with 13 health professionals, using the Pleasure and Suffering at Work Scale and Work Context Assessment Scale for data collection. **Results:** The results showed the main variables that can contribute to the pleasure and / or the task of not working, and the risks of becoming ill. **Conclusion:** It is concluded that there is an urgency of enabling spaces for action and intervention in organizations, in order to enhance work pleasure, minimize suffering and consequent illness.

Keywords— Stress, Job Satisfaction, Work. Emergencies.

Prazer E Sofrimento No Trabalho: Estudo Com Profissionais De Saúde Atuantes Em Unidades De Urgência

Resumo— Objetivo: O estudo teve por objetivo identificar os possíveis fatores causadores de prazer e de sofrimento no contexto de trabalho de profissionais de saúde que desempenham o cargo de coordenadores de equipe em serviços de atendimento de urgência e emergência. **Métodos:** A amostra foi feita com 13 profissionais de saúde, utilizou-se a Escala de Indicadores de Prazer e Sofrimento no Trabalho e a Escala de Avaliação do Contexto de Trabalho para coleta de dados. **Resultados:** Os resultados evidenciaram as principais variáveis que podem contribuir para o prazer e/ou para o sofrimento no trabalho, e os —riscos de adoecimento. **Conclusão:** Concluímos que é urgente a viabilização de espaços de escuta e intervenção nas organizações, de forma a potencializar o prazer no trabalho, minimizando o sofrimento e, consequente adoecimento.

PALAVRAS-CHAVE— Estresse. Satisfação no trabalho. Trabalho. Emergências.

Prazer Y Sufrimiento En El Trabajo: Estudio Con Profesionales De Salud Actuantes En Unidades De Urgencia

Resumen— *Objetivo: El estudio tuvo por objetivo identificar los posibles factores causantes de placer y de sufrimiento en el contexto de trabajo de profesionales de salud que desempeñan el cargo de coordinadores de equipo en servicios de atención de urgencia y emergencia. Métodos: La muestra fue hecha con 13 profesionales de salud, se utilizó la Escala de Indicadores de Placer y Sufrimiento en el Trabajo y la Escala de Evaluación del Contexto de Trabajo para la recolección de datos. Resultados: Los resultados evidenciaron las principales variables que pueden contribuir para el placer y / o el sufrimiento en el trabajo, y los riesgos de enfermedad. Conclusión: Concluimos que es urgente la viabilización de espacios de escucha e intervención en las organizaciones, de forma a potenciar el placer en el trabajo, minimizando el sufrimiento y, consecuentemente la enfermedad.*

Palabras Clave— *Estrés, Satisfacción en el trabajo, Trabajar, Emergencias.*

I. INTRODUCTION

Marx (1996: 71) conceptualizes work as "[...] a process between man and nature, a process in which man, by his own action, mediates, regulates, and controls his metabolism with Nature". In this relation, humans act on the nature that surrounds them, modifying it, at the same time that they modify themselves.

Work is a relevant factor in the life of man and has been going through the years undergoing major transformations in all spheres, mainly as a consequence of technological innovations that have led to the mechanization of operational work, and increased psychic suffering (DEJOURS; DERANTY, 2015).

In order to investigate the mental consequences of the work, between 1950 and 1960 appears in France the Psychopathology of the Work, a discipline that deals with the psychic suffering due to the organization of the work (DERANTY; 2009). Cristophe Dejours is undoubtedly the greatest representative of this theoretical approach and, over time, found that the great enigma of Work Psychopathology was not mental illness but rather normality, leading to an understanding of the defensive strategies (individual and / or collective) adopted by workers in order to avoid disease and achieve psychic balance (MERLO; MENDES, 2009).

From this finding, it was proposed to change the name of the discipline for Psychodynamics of Work (GIONGO; MONTEIRO; SOBROSA, 2009; MENDES, 2009). In this context, the organization of work is the central point for the investigation of the dimensions of the human condition (MENDES, 2009), but it not only addresses suffering but also pleasure in work activities.

The changes that have occurred and are still occurring in the world of work have affected the health of workers in an intensive manner. In the hospital environment, in some cases, the environment can become unhealthy, difficult and dangerous for workers. The hospital activities, as well as in the industries, are fragmented which produces workers now compromised and now unmotivated (ELIAS; NAVARRO, 2006).

The worker who develops his functional activities in hospital services of emergency and emergency attendance constantly experiences situations of decision making and deals with the unpredictable that can contribute to the increase of the suffering and the stress (ALMEIDA, 2007).

The activities that are performed in the hospital environment have a complexity and uniqueness in relation to the various types of work that exist, and because it is an essential work of 24-hour care in an emergency and emergency situation, it causes a lot of wear and tension. The services are continuously adjusted to the needs and demands of the clients, making the workers experience continuous innovation, agility, creativity and proactivity to plan and face the changes, which can lead to suffering (BOUYER, 2010).

Health work is the conjuncture of the relationship between the professional and the users. It is in this meeting that the light technology is developed, that is, the production of communication between the health worker and the patient. This relational dimension can enable both a positive factor and a negative factor in the worker's mental health (GLANZNER; OLSCHOWSKY; KANTORSKI, 2011).

The pleasure of the professional in the exercise of his activities is to see that his work is being fulfilled in a satisfactory way. Displeasure is related to the way your work is organized and the conditions under which it is provided. Although hospital work is seen as exhausting, it is noted as a source of pleasure for the possibility of helping others (ROSA; CARLOTTO, 2005; MARTINS; ROBAZZI; GARANHANI, 2009).

Organizations are assuming ever more strategic roles and the way professionals face this strategic challenge can be a source of suffering and/or pleasure, and it is important to know their possible triggering factors, which legitimizes the relevance of this study (CASTRO; CANÇADO, 2009).

Faced with these issues, we understand that this study is relevant, as it is current because of the constant changes in the process of sickness of health professionals that require their approach in the training processes to meet the demands of individuals and services. It also enables reflection and a greater understanding of the characteristics and particularities of the work in the context of urgency and emergency.

Thus, the present research aimed to identify the possible factors causing pleasure and suffering in the work context of health professionals who perform the position of team coordinators in urgency and emergency care services.

II. METHOD

The survey consisted of the total number of health professionals only of the emergency and emergency services (n = 13), who occupied the position of team coordinator in the emergency department, as the main labor activity, distributed in two categories: Nurses and Doctors. All of them met the inclusion criteria: working in the role of team coordinator of the Emergency Department for at least one year.

This research used as an instrument of data collection a closed questionnaire composed of two parts. The first part of the questionnaire required demographic and functional data of the respondent, namely: gender, training course, marital status, age, professional working time. The second part of the questionnaire referred to the Work Inventory and Risk of Sickness Scale (WIRS), developed by Mendes and Ferreira (2007): the Pleasure and Suffering at Work Indicator Scale (PSWIS) and the Working Context Evaluation Scale (WCES). It should be stressed that none of the participants gave up during this process and no problems were identified for the collection of data.

The PSWIS scale describes the meaning of the work demonstrating representations regarding the experiences of pleasure and suffering at work, and the WCES describes the context of the work, referring to representations related to the organization, the socio-professional relations and the working conditions. The first one consists of 32 descriptive inferences, grouped into four variables: "Professional Realization" and "Freedom of Expression" referring to pleasure; "Professional Exhaustion" and "Lack of Recognition" associated with suffering. The second contains 31 descriptive inferences, grouped into three variables: "Work Organization", "Working Conditions" and "Socio-professional Relations".

In this context, the PSWIS and WCES have the purpose of assisting in the diagnosis of critical indicators at work, aiming at a descriptive analysis of the real, outlining a profile of some factors that may lead the worker to illness. The parameters for the evaluation and interpretation of the results obtained through the WCES and PSWIS were summarized in Table I.

Table I - Parameters for the evaluation and interpretation of the results obtained through the WCES and PSWIS.

Scale	Parameters	Level	Evaluation
Working Context Evaluation Scale (WCES)	Over 3.7	Severe	More Negative
	Between 2.3 and 3.69	Critical	Moderate
	Under 2.29	Satisfactory	Positive
Pleasure and Suffering at Work Indicator Scale (PSWIS)	Over 4.0	Severe	More Negative
	Between 3.9 and 2.1	Critical	Moderate
	Under 2.0	Satisfactory	Positive

Source: MENDES and FERREIRA, 2007.

Data collection began in the months of February to April 2015, at a time previously scheduled with all participants. The quantitative descriptive case study

included professionals from four hospitals of the Hospital Foundation of the State of Minas Gerais (FHEMIG), located in the city of Belo Horizonte (MG), which

provide emergency and emergency services to the population. The unit of analysis chosen in this research was the working context of the health professionals of the emergency and emergency services of the FHEMIG Network.

According to Decree 45.691, of August 12, 2011, FHEMIG provides hospital and health services, at a regional and state level, at secondary and tertiary levels of complexity, through a hospital structure integrated with the Unified Health System (UHS) , with administrative and financial autonomy grouped in 21 care units in the State of Minas Gerais (MINAS GERAIS, 2011). The scenarios of this study were the hospital units are part of the emergency and emergency complex located in the city of Belo Horizonte the study scenario.

Regarding the profile of care, the main services offered by the four hospitals concern: care for victims of major burns; urgent medical care for orthopedic trauma in victims of serious accidents; medical care in cases of poisoning or severe intoxication; medical and hospital care for injured people in cases of major catastrophes; urgent surgeries for patients at risk of death; urgent medical clinic service; medical treatment for adults in need of intensive and intermediate care; child care for pediatric emergencies and emergencies, infectious diseases and complex diseases; oncology. The specialties contemplated are: general surgery; medical clinic; pediatrics; neurology, neurosurgery; orthopedics; restorative plastic surgery; oral and maxillofacial surgery and traumatology; otorhinolaryngology; intensive medicine; anesthesiology; cardiovascular surgery; ophthalmology.

For the analysis of the results the statistical package *Statistical Package for Social Science* (SPSS) version 19 was used. The data obtained through this statistical program were systematized in tables and graphs for a better understanding of the results. The elements that compose the factors related to PSWIS and WCES were grouped in tables following the order of each scale. The descriptive and univariate statistical analysis of the data obtained included the determination of absolute frequency and percentage frequency distributions, mean, standard deviation, maximum values and minimum values.

This study began after the authorization of the Ethics and Research Committees of the Federal

University of Minas Gerais and the Hospital Foundation of the State of Minas Gerais (CAAE 38956614.2.0000.5149 and 38956614.2.3001.5119, respectively). All requirements of Resolution 466 of December 12, 2012, which regulate research involving human beings were met (BRASIL, 2012).

III. RESULTS

The sample of this research was composed of 13 health professionals from the emergency and emergency services (n = 13), who were the coordinator of the emergency room team of four FHEMIG hospitals, located in Belo Horizonte (MG).

The predominant profile of the analyzed sample was of female participants (69.23%), age between 29-38 years (53.85%), the predominant training course was Medicine (61.54%), marital status married (53.85%), and professional time as a team coordinator from one year to ten years (53.85%).

The following are the results of PSWIS and WCES, which allowed the identification of possible risks of illness at work.

3.1 Pleasure and Suffering at Work Indicator Scale (PSWIS)

The PSWIS is composed of the factors "Freedom of expression" and "Professional realization" - related to pleasure - and "Professional exhaustion" and "Lack of recognition" - associated with suffering (MENDES; FERREIRA, 2007).

In PSWIS the items are evaluated by a seven-point Likert scale, where 0 = no time, 1 = once, 2 = twice, 3 = three times, 4 = four times, 5 = five times, 6 = six or more times.

They are considered as results for PSWIS factors related to *pleasure at work*: below 2.0 = evaluation for rarely at a serious level; between 2.1 and 3.9 = moderate evaluation at critical level; above 4.0 = more positive evaluation at satisfactory level.

As can be seen in Table II, the results of the experience of *pleasure at work* analyzed based on the factors "Freedom of Expression" and "Professional Achievement", had the averages of 4.09 and 3.92, respectively. The first factor presents a positive evaluation at a satisfactory level, and the second a moderate assessment at a critical level.

Table II - Descriptive statistics of the four PSWIS variables

Factor	General media	Level	Evaluati on
Freedom of expression	4.09	Satisfactory	Positive
Professional achievement	3.92	Critical	Moderate
Professional Exhaustion	3.02	Critical	Moderate
Lack of Recognition	2.26	Critical	Moderate

Source: Research Data, 2015.

For the PSWIS factors associated with suffering at work, the following are considered as results: below 2.0 = positive evaluation at satisfactory level; between 2.1 and 3.9 = moderate evaluation at critical level; above 4.0 = more negative evaluation at the severe level. According to data from Table II, it can be observed that the variable Professional Exhaustion received a slightly higher mean (3.02) than Lack of Recognition (2.26), making it more negative for the health of the professional, even so, the

two evaluations can still be considered moderate at critical level.

Table III presents the detail of the set of items belonging to each of the four factors. It is observed that the items that most provide the feeling of pleasure are related to: "freedom to express their opinions" (4,45); "Talk to colleagues about work" (4,44); of "negotiation with the chief" (4,35); "Pride in what he does" (4,56); "Professional achievement" (4,33); and "general well-being" (4,09).

Table III - Descriptive statistics of the four variables and the PSWIS items

Factor	Items	Average
Freedom of expression	Freedom with the leadership to negotiate what you need	4.35
	Freedom to talk about my work with colleagues	4.44
	Solidarity among colleagues	3.95
	Trust among colleagues	3.73
	Freedom to express my opinions in the workplace	4.45
	Freedom to use my creativity	4.04
	Freedom to talk about my work with the bosses	4.11
	Cooperation among colleagues	3.62
Professional achievement	Satisfaction	3.85
	Motivation	3.95
	Pride for what I do	4.56
	Well being	4.09
	Professional achievement	4.33
	Appreciation	3.47
	Recognition	3.07
	Identification with my tasks	4.15
Personal gratification with my activities	3.85	
Professional Exhaustion	Emotional exhaustion	3.31
	Stress	3.56
	Insatisfaction	2.62
	Overload	3.78
	Frustration	3.04
	Insecurity	2.55
	Fear	2.31
Lack of Recognition	Lack of recognition of my effort	2.64
	Lack of recognition of my performance	2.64
	Devaluation	2.40
	Indignation	2.91
	Uselessness	1.76
	Disqualification	1.82
	Injustice	2.27
	Discrimination	1.60

Source: Research Data, 2015.

Among the items that most contribute to suffering are "stress" (3.56) and "overload" (3.78).

3.2 Working Context Evaluation Scale (WCES)

The description of the work context are representations related to the variables "Work

organization", "Socio-professional relations" and "Working conditions", evaluated through the WCES (MENDES, 2007). In WCES the items are evaluated by a five-point Likert scale, where 1 = never, 2 = rarely, 3 = sometimes, 4 = frequently, 5 = always. The following are considered as results for WCES factors: below 2.29 = more positive, satisfactory evaluation; between 2.3 and 3.69 = more moderate evaluation at critical level; above

3.7 = more negative evaluation at a serious level (MENDES; FERREIRA, 2007).

The results of the descriptive statistics regarding the WCES variables and the factors that compose this scale are presented in Table IV. As it is possible to observe, all the variables present critical level, with moderate evaluation.

Table IV - Descriptive statistics of the three WCES variables

Factor	General Average	Level	Evaluation
Work organization	3.68	Critical	Moderate
Work Conditions	3.20	Critical	Moderate
Socio-professional Relations	2.89	Critical	Moderate

Source: Research data, 2015.

Table V presents the detail of the set of items belonging to each of the three variables. It is observed that the items that most provide a negative evaluation at a serious level in the variable Labor Organization are: "excessive work rhythm" (4.23); "Strong collection for results" (4,15); Term pressure (3.92); and "insufficient number of employees to perform the tasks" (3.92).

Table V - Descriptive statistics of the three variables and WCES items

Factor	Items	Average
Work Organization	The pace of work is excessive	4.23
	Tasks are met with time pressure	3.92
	There is strong charge for results	4.15
	The norms for carrying out the tasks are strict	3.46
	Performance monitoring exists	3.69
	The number of people is insufficient to perform the tasks	3.92
	Specific results are out of touch	2.92
	There is a division between who plans and who executes	3.38
	Tasks are repetitive	3.31
	Time to take rest breaks at work	3.85
Work conditions	The tasks performed suffer discontinuity	3.62
	Working conditions are precarious	3.62
	The physical environment is uncomfortable	3.46
	There is a lot of noise in the work environment	3.15
	The furniture in the workplace is inadequate	3.23
	The instruments of work are insufficient to carry out the tasks	3.38
	The workstation is inadequate to perform the tasks	2.85
	The equipment required to carry out the tasks is precarious	3.15
	The physical space to do the work is inadequate	2.92
	Working conditions pose risks to the safety of people	3.15
Socioprofessional relations	Consumption material is insufficient	3.08
	Tasks are not clearly defined	2.92
	Autonomy does not exist	2.85
	The distribution of tasks is unfair	2.69
	Officials are excluded from decisions	2.77
	There are difficulties in communication between manager and subordinates	2.38
There are professional disputes in the workplace	3.23	

Lack of integration in the work environment	3.23
Communication between officials is unsatisfactory	3.46
Lack of managerial support for my professional development	2.62
The information I need to perform the tasks is difficult to access	2.77

Source: Research data, 2015.

It should be noted, finally, that no item of any of the variables received a positive evaluation, at a satisfactory level.

IV. DISCUSSION

4.1 Pleasure and Suffering at Work

Our results showed that the items "Freedom to express my opinions in the workplace", "Freedom to talk about my work with colleagues" and "Freedom to negotiate what I need" positively influence the average "Freedom of expression". This variable points out that pleasure seems to be linked to the possibility of participation in decisions, the support of the bosses for the development of work, autonomy and freedom of expression. Such results confirm the logic of work as capable of providing pleasure and becoming part of the psychic economy as an irreplaceable mediator in the construction of a sense of health and self-realization (DEJOURS; DERANTY, 2015).

In this way, the freedom to think about the scope of work minimizes suffering by taking the worker to an experience of pleasure together with the structuring of psycho-affective coexistence with colleagues, a fact that corroborates our results. We can also infer that pleasure is part of the attempt to transform the reality that surrounds the subject in his own desires, that is, pleasure in work is the coherence between the aspects of work and the psychic needs and desires of the worker. A study carried out with workers from a commercial building diverges from our findings, as this showed a critical level for this factor, indicating a state of alert, indicating a need for intervention in the short and medium term (MARTINS; ROBAZZI; GARANHANI, 2009; FERREIRA; MENDES, 2001; DEJOURS, 1992).

Pleasure should be seen as a structuring factor of the work, and can be experienced to the extent that the individual manages to exert some influence in the way the work is planned and organized, resulting in a greater commitment to the process and its results (BEN, 2004). "It is through this recognition of the contribution of the subject that the suffering necessarily involved in the work can be sublimated into pleasure, that is, an experience of subjectivity or of an increase of identity" (DERANTY, 2009, p. 45).

The process of people management is permeated by the ability to plan and organize the processes of teamwork, so the participants of this study reaffirm their

potential of pleasure in work subjectively consolidating their identity as unit coordinator.

However, in a detailed analysis of the other items of this factor ("Freedom of Expression"), it is worth mentioning that the descriptors that negatively influenced the averages were "peer solidarity", "peer trust" and "", Presenting a moderate assessment and critical level, which indicates that social interactions need to be improved.

We understand that cooperation is related to the will of individuals to work as a team, in order to collectively overcome the contradictions of the work organization itself. Cooperation as an element relating to the freedom factor cannot be prescribed and its absence can lead to a blockade of production (LANCMAN; SZNELWAR, 2008).

When analyzing the variable "Professional Achievement", we verified that the item "recognition" obtained the lowest average (3.07), being considered as critical level. The best evaluation descriptions were "professional achievement" and "pride in what I do" that relate the person's identification with their work. The results of the analysis of the items of this variable influenced more negatively the general averages (3.92) and indicated critical level and moderate evaluation.

It is undeniable that recognition is one of the elements of great importance in the daily life of the worker, being considered as a significant factor for the development of the professional, acting directly on their motivation. We emphasize that our results presented an average for the item "motivation" of 3.95, which although the evaluation is considered moderate, is very close to the average of a satisfactory evaluation; thus we understand that the health professionals participating in this study are in a tenuous context between motivation and demotivation which can directly impact the work process and inter-professional relations.

Professional Realization confirms that pleasure and recognition are ideas that interact with each other and are central elements for the understanding of suffering, assigning a new meaning to the organization of work. In this perspective, the recognition and motivation that in this study denote a critical state / level, can mean fragility

in the socio-professional relations (MENDES, 2007; FERREIRA; MENDES, 2001).

The variables "Professional Exhaustion" and "Lack of Recognition" are considered to cause suffering and distress. The analysis of the results of this research registered general averages of 3.02 and 2.26 for such variables concurrently, thus registering a critical level and moderate evaluation for both.

The "stress" (3.56) and the "overload" (3.78) are the items that contribute the most to the Professional Exhaustion according to the interviewees, obtaining the highest averages. The current literature is consensual in stating that stress is a factor that requires a lot of attention, since it can lead the worker to physical and psychic illness. The most common physical symptoms are headaches, insomnia, and fatigue; and the psychic symptoms refer to anxiety, depression, decreased concentration and fear (KARASEK; THEORELL, 1990). Work overload can also be harmful to the professional as it culminates in work accidents, dissatisfaction, and a growing desire to quit (SCHMOELLER; et al, 2011). These negative effects are due to the fact that the exhaustive workload interferes in the moral and functional capacity of the nurses besides culminating in damages to the health of the patients (MANETTI; MARZIALE, 2007).

Suffering may be concealed from the defense strategies that the individual will produce in his work context, but this concealment of suffering can be potentiated causing physical damage to the health of the worker, which may result in removal from work and/or loss in productivity and quality of services provided (MOUTINHO, 2011).

In view of these results, it is necessary to reflect on the suffering caused by the professional exhaustion that can lead to a decrease in income at work and may be the result of the organization and working conditions to which the health professionals participating in this study are exposed. Suffering enters the life of the person independent of their will or institutional orders, this may be due to the organization of the activities developed and has been studied throughout the history of the work, but without due attention as a reaction of the worker (BRANT; GOMEZ, 2007; BRANT; GOMEZ, 2009).

Finally, the variable "*Lack of Recognition*" that evaluates the experience of injustice, indignation and devaluation by the non-recognition of their work, obtained a general average of 2.26. In this work, a general low average was observed, but still at the critical level, moderate evaluation; (2.91), "*lack of recognition of my*

effort" (2.64) and "*lack of recognition of my performance*" (2.64).

Recognition is part of a process of valuing the suffering employed in the work, so their lack generates a sense of injustice and causes workers to draw defensive strategies to deviate from mental illness. If the dynamics of recognition are no longer worked by the individual, suffering can no longer be transformed into pleasure which can result in experiences of indignation and devaluation, in order to compromise the identity in the work (MENDES, 2007; BOUYER, 2010).

This analysis of PSWIS results showed that the health professionals participating in this study experience both pleasure experiences and experiences of suffering at work, as presented in other studies (ALMEIDA; PIRES, 2007; CASTRO; CANÇADO, 2009; AUGUSTO; FREITAS; MENDES, 2009, PRESTES; et al, 2014).

This finding allows us to think that there is pleasure and it can counteract the suffering experienced by the respondents, which can contribute to the psychic balance. Even motivated by suffering, the subject has the potential to promote changes in the way of working through autonomy, leading him to transform or reduce suffering (LANCMAN; SZNELWAR, 2008).

Modern man sees in work a form of salvation, a way of overcoming uselessness and meaninglessness in life, however, the present society consumes the individual and transforms it into a mechanical being that is becoming only a part of a larger gear which seeks to frame life in models and despises subjectivity. The machine man becomes a product or a function for society, it dominates the technologies, but it is unknown as a subject, that is, it lives a alienation of the emotions and the senses (SIQUEIRA, 2008).

4.2 Work context

The variable "*Work Organization*" analyzes the division and content of tasks, norms, controls and work rhythm. From the analysis of our results we can understand that this variable is in a critical situation and very close to the serious condition (3,68), which requires greater attention so that there is no risk of illness with a negative result and cost producer and suffering at work (MENDES, 2007).

In the particular analysis of the items composing this variable, "*Pay for results*", "*work rate*" and "*insufficient number of people to perform the tasks*", were evaluated by professionals as severe, in which the averages were 4.15, 4.23 and 3.92 respectively.

The organization of work generates contradictory forces on the professional that confront the desire of the

individual and the reality of work, such as doing more versus doing good. In this scenario, we perceive that the transformation of suffering is based on the freedom of the worker to adjust the reality of the work to their needs (MENDES, 2009).

The second factor analyzed was the variable "Working Condition" that defines the quality of the physical environment, the work station, the equipment and materials made available for the work (MENDES, 2007). In this study, the analysis of the data resulted in an average value of 3.20 which presents borderline situation being considered critical level, moderate evaluation.

The items that presented lower averages, based on the statistical analysis of this research, were: "*The physical space to perform the work is inadequate*" and "*the workstation is inadequate to carry out the tasks*" presenting averages of 2.92 and 2.85 respectively. Hereafter, the items with the highest averages of the applied scale were "*Working conditions are precarious*" with a mean of 3.62 and "*The physical environment is uncomfortable*" with an average of 3.46. Although different, all the results point to a critical level and moderate evaluation which means lessened risk of illness, but which demand the implementation of measures in the causes in order to eliminate them and/or to mitigate them.

The precariousness of working conditions, the experience with the pain of the other, the existence of accumulation of positions and the increase in the scale of work can lead the health professional to the psychic suffering. The prolongation of the time dedicated to work due to the long journey reduces the time of family life being a factor of distress for the health professional (ROSA; CARLOTTO, 2005).

The last factor that makes up the WCES relates to the variable "*Socio-professional Relations*" which analyzes the modes of work management, communication and professional interaction (MENDES, 2007). The analysis culminated in an average value of 2.89, which is also a critical factor and indicates a state of alertness. In the particular analysis of the items we highlight "*The communication between employees is unsatisfactory, with an average of 3.46,*" "*There are professional disputes in the workplace*", with a mean of 3.23 and "*Lack of integration in the work environment*", where the mean was 3.23. The lower value items were: "*There are difficulties in communication between manager and subordinates*", with a mean of 2.38 and "*Lack of managerial support for my professional development*", with an average of 2.62. Corroborating with the other variables related to the WCES presented, this one is also characterized with critical level and moderate evaluation.

These results converge with a study carried out with workers of a public research foundation, published in 2014, that sought to characterize the work context in all its dimensions; besides describing the experiences of pleasure and suffering, and investigating the mechanisms used to mediate suffering. Among its results, we emphasize that working conditions have proved to be precarious in terms of job design, which contributes to the destruction of relationships in public organizations, which can have undesirable consequences on the quality of services rendered to society (AUGUSTO; FREITAS; MENDES, 2015). This congruent finding, points to the need for inter-professional cooperation which is an additional element in the organization of work, which helps to overcome the contradictions presented and must be allied to trust between individuals.

As a limitation, it is possible to indicate that the qualitative approach was not used concomitantly with the quantitative approach. Mendes and Ferreira (2007) recommend the use of PSWIS and WCES in conjunction with other techniques, aiming at an apprehension based on different looks on the object of study. Thus, it is suggested for future research the use of the qualitative approach together with the quantitative approach to investigate the possible risks of illness of these workers.

However, this research was a great contribution in the academic field, since it collaborates to generate knowledge on the theme "health and work" and stimulate the development of new researches with health professionals based on the scientific approach of work psychodynamics. In the organizational context, the diagnosis of occupational health risks assists the health services in recognizing the possible risks of illness and also enables the use of the results by the participants themselves, to benefit the transformation of the work context.

V. CONCLUSION

The relevance of this study is the collection of data that can identify the main variables that may contribute to pleasure and / or suffering at work; in addition to the aspects related to the work context identified, which may represent risks of sickness of the health professionals who work in the emergency and emergency services occupying the position of team coordinator of the Emergency Care Sector.

The results of this research allow us to conclude that it is necessary to rethink the organization of work, the exercise of power, ethics, and especially the way of dealing with suffering and its consequences for the subject and the community. There is an urgent need to

create spaces for listening and intervention in organizations, so that work groups can be set up in all health services.

It is important to emphasize the importance of the implementation of permanent education actions on this subject in the services that were part of this study to minimize the risks of psychic illness of its workers. It is suggested to hold workshops, discussion groups and work activities that stimulate worker participation in an exercise of reflection and mutual cooperation aimed at improving work processes and inter-professional interaction, enhancing work pleasure, minimizing suffering and consequent illness.

INTEREST CONFLICTS

The authors of this paper have no conflicts of interest of any nature to declare.

SUPPORT

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REFERENCES

- [1] ALMEIDA, Paulo Jorge dos Santos, PIRES, Denise Elvira Pires de. O trabalho em emergência: entre o prazer e o sofrimento. **Revista Eletrônica de Enfermagem [online]**, Goiânia. v. 9, n. 3, p. 617-629, set.dez. 2007. Disponível em: <<https://www.fen.ufg.br/revista/v9/n3/pdf/v9n3a05.pdf>>. Acesso em: 20 de fev. 2018.
- [2] AUGUSTO Magda Maria; FREITAS Lêda Gonçalves de; MENDES Ana Magnólia. Vivências de prazer e sofrimento no trabalho de profissionais de uma fundação pública de pesquisa. **Psicologia em Revista**, Belo Horizonte. v. 20, n. 1, p. 34-55, abr. 2014.
- [3] BEN, Luiza Watanabe Dal; et al. A percepção da relação sofrimento/prazer no trabalho de auxiliares e técnicos de enfermagem em internação domiciliar. **Revista Cogitare Enfermagem**, Curitiba. v. 9, n. 2. p. 73-81, 2004.
- [4] BOUYER, Gilberto Cardoso. Contribuição da psicodinâmica do trabalho para o debate: “o mundo contemporâneo do trabalho e a saúde mental do trabalhador”. **Revista Brasileira de Saúde Ocupacional**, São Paulo. v. 35, n. 122, p. 249-259, jul.dez.2010.
- [5] BRANT; GOMEZ. Dispositivos de transformação do sofrimento em adoecimento numa empresa. **Revista Psicologia em Estudo**. v. 12, n. 3, p. 465-473, set./dez.2007.
- [6] BRANT Luiz Carlos; GOMEZ, Carlos Minayo. Manifestação do sofrimento e resistência ao adoecimento na gestão do trabalho. **Revista Saúde Sociedade**, São Paulo. v. 18, n. 2, p. 237-247, ISSN 0104-1290. 2009.
- [7] BRASIL. Ministério da Saúde. Resolução N° 466, de 12 dezembro de 2012. Aprova as diretrizes e normas regulamentadoras de pesquisas envolvendo seres humanos. **Conselho Nacional de Saúde**, Brasília, 12 dez. de 2012. Disponível em: <<http://conselho.saude.gov.br/resolucoes/2012/Reso466.pdf>>. Acesso em: 14 out. 2017.
- [8] CASTRO, Patrícia Maciel; CANÇADO, Vera Lúcia. Prazer e Sofrimento no Trabalho: a vivência de profissionais de recursos humanos. **Revista Gestão e Planejamento**, Salvador. v. 10, n. 1, p. 19-37, jan. /jun. 2009.
- [9] DEJOURS, Christophe. **A loucura do trabalho: estudo de psicopatologia do trabalho**. 5. ed. São Paulo: Editora Cortez, 1992.
- [10] DEJOURS, Christophe; DERANTY, Jean Philippe. The centrality of work. **Critical Horizons**, London. v. 11, n. 2, p. 167-180, abr. 2015.
- [11] DERANTY, Jean Philippe. What is work? Key insights from the psychodynamics of work. **Thesis Eleven**. v. 98, n.1, p. 69-87, jul. 2009.
- [12] ELIAS, Maria Aparecida; NAVARRO, Vera Lúcia. A relação entre o trabalho, a saúde e as condições de vida: negatividade e positividade no trabalho das profissionais de enfermagem de um hospital escola. **Revista Latino Americana em Enfermagem**, Ribeirão Preto. v. 14, n. 4, p. 517-525, jul/ago. 2006.
- [13] FERREIRA, Mário César; MENDES, Ana Magnólia. “Só de pensar em vir trabalhar, já fico de mau humor”: atividade de atendimento ao público e prazer-sofrimento no trabalho. **Revista Estudos de Psicologia**, Natal. v. 6, n. 1, p. 93-104. ISSN 1678-4669. 2001.
- [14] GIONGO, Carmem Regina; MONTEIRO, Janine Kieling; SOBROSA, Gênesis Marimar Rodrigues. Psicodinâmica do trabalho no Brasil: revisão sistemática da literatura. **Temas em Psicologia**, Ribeirão Preto. v. 23, n. 4, p. 803-814, dez. 2015.
- [15] GLANZNER, Cecília Helena; OLSCHOWSKY, Agnes; KANTORSKI, Luciane Prado. O trabalho como fonte de prazer: avaliação da equipe de um Centro de Atenção Psicossocial. **Revista da Escola de Enfermagem da Universidade de São Paulo [online]**, São Paulo. v. 45, n. 3, p. 716-721. 2011.
- [16] KARASEK, Robert; THEORELL, Tores. **Healthy of work: stress, productivity and the reconstruction of working life**. 1. ed. New York: Publishing company Basic Books, 1990.
- [17] LANCMAN, Selma; SZNELWAR, Laerte Idal. **Christophe Dejours: da psicopatologia à psicodinâmica do trabalho**. 2. ed. Rio de Janeiro: Fiocruz, 2008.
- [18] MANETTI Marcela Luísa; MARZIALE, Maria Helena Palluci. Fatores associados à depressão relacionada ao trabalho de enfermagem. **Revista Estudos de Psicologia**, Natal. v. 12, n. 1, p. 79-85, jan. /abr. 2007.
- [19] MARTINS, Júlia Trevisan; ROBAZZI, Maria Lúcia do Carmo Cruz; GARANHANI, Maria Lúcia. Sentimentos de prazer em enfermeiros de unidades de terapia intensiva. **Revista Ciência y Enfermería**, Concepcion. v. 15, n. 3, p. 45-53, ISSN 0717-2079. 2009.

- [20] MARX, Karl. O Capital. v.1 Tomo 1. São Paulo: Editora Nova Cultural Ltda,1996.
- [21] MERLO, Álvaro Roberto Crespo; MENDES, Ana Magnólia Bezerra. Perspectivas do uso da psicodinâmica do trabalho no Brasil: teoria, pesquisa e ação. **Cadernos de Psicologia Social do Trabalho**, São Paulo. v.12, n. 2, p. 141-156, dez. 2009.
- [22] MENDES, Ana Magnólia. **Psicodinâmica do Trabalho: teoria, método e pesquisas**. 1. ed. São Paulo: Casa do Psicólogo, 2007.
- [23] MENDES, Ana Magnólia. **Trabalho e Saúde: o sujeito entre emancipação e servidão**. In: MENDES A. M. **Prazer, reconhecimento e transformação do sofrimento no trabalho**. 1. reimpr. Curitiba: Juruá Editora, 2009.
- [24] MENDES Ana Magnólia; FERREIRA, Mário C. **Inventário sobre Trabalho e Riscos de Adoecimento – ITRA: instrumento auxiliar de diagnóstico de indicadores críticos no trabalho**. In: MENDES, Ana Magnólia. **Psicodinâmica do trabalho: teoria, método e pesquisas**. 1. ed. São Paulo: Casa do Psicólogo, 2007.
- [25] MINAS GERAIS. Decreto nº 45.691, de 12 de agosto de 2011. Contém o Estatuto da Fundação Hospitalar do Estado de Minas Gerais – FHEMIG. **Assembleia Legislativa de Minas Gerais**. 12 ago. de 2011. Disponível em: <http://jornal.iof.mg.gov.br/xmlui/bitstream/handle/123456789/144575/caderno1_2015-05-22%2021.pdf?sequence=1>. Acesso em: 14 jan. 2018.
- [26] MOUTINHO, Lídia Clément Figueira. Efeitos da Organização do Trabalho Sobre a Saúde do Trabalhador - Uma Breve Análise Partindo das Abordagens de Nise Jinkings e Christophe Dejours. **Revista do Tribunal Regional do Trabalho do Paraná da 9ª Região**. v. 36, n. 67, jul. /dez. 2011.
- [27] PRESTES, Francine Cassol; et al. Indicadores de prazer e sofrimento no trabalho da enfermagem em um serviço de hemodiálise. **Revista da Escola de Enfermagem da Universidade de São Paulo**, São Paulo. v. 49, n. 3, p. 465-472, 2015.
- [28] ROSA Cristiane da, CARLOTTO, Mary Sandra. Síndrome de Burnout e satisfação no trabalho em profissionais de uma instituição hospitalar. **Revista Brasileira de Psicologia Hospitalar [online]**, Belo Horizonte. v.8, n. 2, ISSN 1516-0858. 2005.
- [29] SCHMOELLER, Roseli; et al. Cargas de trabalho e condições de trabalho da enfermagem: revisão integrativa. **Revista Gaúcha de Enfermagem [online]**, Porto Alegre. v. 32, n. 2, p. 368-377, jun. 2011.
- [30] SIQUEIRA, Ailton. Ética e trabalho. **Revista Contexto**, Rio Grande do Sul. v. 3, n. 3, p. 27-44, jan. /jun. 2008.

Evaluation of Pain Intensity and Analgesia used in Patients in the Postoperative Period in a Hospital in the Interior of Bahia

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Abstract— Pain is a detestable emotional, sensory experience that usually occurs in varying degrees of intensity, identifying itself as multidimensional, as high in quality as in intensity, being able to result from nerve stimulation as a result of injury, emotional disturbance or disease. In this way it makes possible the certification in which pain is a singular and particular experience. The present study aims to evaluate the intensity of pain and analgesia used in patients in the postoperative period in a hospital in the interior of Bahia. This is a quantitative, descriptive and cross-sectional study conducted in a public hospital in the interior of Bahia through a structured questionnaire and the analysis of medical prescriptions. The research involved 50 participants who underwent surgical procedures. NVS was used to assess pain intensity. The data were analyzed in the statistical program SPSS 22.0. The predominance of the male gender (78%) and the age groups of 62-72 years (32%) were observed. In addition, 64% of the participants presented prescription of some type of opioid. 86% presented some type of pain and 76% had mild pain. The results of this research indicate the need for systematic evaluation of pain in postoperative patients, aiming at its control, contributing to the recovery of these patients. **Keywords**— Analgesia; Post-Operative Pain; Pain Evaluation.

I. INTRODUCTION

The word Pain originates from Latin *dolor* and Greek *algos*, which gave rise to the terms *doleur* in French, *pain* in English, *dolore* in Italian and *pain* in Portuguese (SAÇA et al., 2010).

According to IASP - The International Association for the Study of Pain (1986) establishes pain according to a complicated emotional and sensory experience, added to actual or latent, subjective at all times. It is identified as a multidimensional experience, in a high degree in quality as in intensity, with autonomic, affective, behavioral and sensorial points (DELLAROZA et al., 2012).

According to Meier and collaborators (2017), this definition makes possible the certification in which pain is a singular and particular experience, in this way pain is a subjective experience that is correlated not only with the

sensorial constituent but also with an emotional constituent. thus be described as subjective.

The definition of clinical pain poses a great challenge to researchers, taking into account the subjectivity, difficulty and dimension of pain giving meaning to the patient. Over 20 years, there were improvements related to the production of resources, which facilitated the relationship in the patients' lives with the responsible professionals, allowing to identify both the occurrence, persistence and potency of the pain felt, according to the reduction acquired through the use of several analgesic strategies (PEREIRA and SOUZA, 1998).

Postoperative pain (DPO) is frequent and expected after large and medium-sized operations resulting from activation of nociceptors and local inflammatory response

at the site of surgical injury. Some writers argue that the following sympathetic activation of the surgical lesion remains following the procedure and is capable of leading to potentially harmful situations to the point of causing hypertension, tachycardia, immune suppression, hyperglycemia, reduced local blood flow, and platelet aggregation (TEIXEIRA et al. 2014).

DPO is the patient's own unique and normal occurrence of preservation to the body which constantly arises when a certain tissue is injured, thus causing a reaction in the individual causing him to try to prevent the painful impulse. Due to its high relevance in the postoperative period, the DPO should be moderated to such an extent that it does not affect the patient's well-being, does not provide unnecessary suffering and does not allow other types of complications (BARBOSA et al., 2014).

Regarding the relationship between the drugs used, the World Health Organization (WHO) recommends the association of analgesics with different actions, which decrease the manifestation of possible adverse effects, corresponding to the use of smaller doses, making it essential that the prescription adjust to any need of the patient (BARBOSA et al., 2014).

Considering an extensive alternative in relation to the treatment of OPD, it is indispensable to form protocols in order to improve the questioning about pain (TEIXEIRA et al., 2014).

Therefore, the General Directorate of Health in Circular Normative No. 9 / DGCG of 14/6/2003, indicates pain as the 5th vital sign. Thus, good techniques of useful health activities were established, according to the systematic recording of pain intensity and the application during the measurement of its intensity, of one of the resulting internationally validated scales: Visual Analogue Scale, Quantitative Scale or Face Scale.

According to statements by Bottega and Fontana (2010), the use of pain scales represents a way to humanize care in which the patient's greatest interest is, taking into account what he describes and feels, and is therefore of extreme importance in doing so. that the patient has the right of expression. This method is of great relevance for planning care for the patient's pain and pathology by minimizing their suffering. In this sense, the objective of this study was to evaluate the intensity of pain and analgesia used in patients in the postoperative period in a hospital in the interior of Bahia.

II. MATERIALS AND METHODS

This study is based on a quantitative, descriptive and cross-sectional study carried out in a public hospital

in the interior of Bahia, which is large and caters to highly complex patients. Fifty patients were interviewed and the other data were collected at the Clinical Surgical Unit in the postoperative period. The research was carried out between February and April, using interviews with questionnaires that dealt with socioeconomic aspects, medicines used, obtained through medical prescription and pain intensity evaluation, which were classified by scale.

The Numerical Visual Scale (NVS) comprises a line 10 centimeters long, where it is numbered from 0 to 10. It was considered that "no pain" = 0, "mild pain" = 1-4, "moderate pain" = 5-7 and "severe pain" = 8-10 (CALIL, PIMENTA, 2005).

Inclusion criteria were patients older than 18 years of age who underwent surgical procedure. The exclusion criterion used was the patients who are presenting some type of limitation that does not become fit to participate in the research.

The data were tabulated and analyzed through the statistical program SPSS 22.0. Absolute and relative frequency analyzes were performed. In addition, correlations between the variables were analyzed using the chi-square test or the Fisher's exact test, considering a significance level of 5%.

This study was approved by the Ethics Committee of the Faculdade Independente do Nordeste - FAINOR through opinion no. 3,209,338. Participants signed the Free and Informed Consent Term (TCLE), ensuring the integrity of the work and clarified any doubts about the work addressed.

III. RESULTS AND DISCUSSION

It was reported that the largest percentage were male subjects 78% (n = 38), aged 62-72 years 32% (n = 16). According to Tomasi and collaborators (2017), the male sex presents a higher risk of becoming ill, since the women present a higher life expectancy in relation to the men. Regarding the age group, the index of surgical procedures also increases, establishing an alert for the indispensability of a reorganization of the health system.

Among the participants, 50% (n = 25) declared themselves to be brown, single 50% (n = 25), 74% (n = 37) state that they live at home or apartment with their family, 38% (n = 19) live with a partner, and they may affirm more than one family option.

The variants of religion, catholic 50% (n = 25), schooling were analyzed, in which, from the 5th to 8th grade of elementary school (old gymnasium) and high school completed the same values 24% (n = 12). With respect to the monthly family income of the participants,

according to the Minimum Salary (SM) of 2018, equal to R \$ 954,00 reais, the average salary was from 01 to 03 minimum wages 86% (n = 43). Regarding the occupation,

36% (n = 18) work with a formal contract, and 64% (n = 32) of the interviewees live in another municipality (Table 1).

Table 1 - Socioeconomic data on patients in the postoperative period of a hospital in the interior of Bahia in 2019.

VARIABLES	n	%
Gender		
Male	39	78
Female	11	22
Age Group		
18-28	5	10
29-39	8	16
40-50	4	8
51-61	8	16
62-72	16	32
73-85	9	18
declared color		
White	10	20
Black	8	16
Brown	25	50
Yellow	7	14
Civil Status		
Single	25	50
Married /with a companion	18	36
Widowed	3	6
Divorced / Separated / Disqualified	4	8
Religion		
Catholic	30	60
Protestant / Evangelic	14	28
No religion	6	6
Where do you live?		
In your apartment or home with my family apartment or flat	37 13	74 26
Who do you live with?		
I live alone	13	26
Father and / or mother	15	30
Spouse / Partner	19	38
Children	11	22
Siblings	5	10
Education		
Did not study	6	11
From 1st to 4th grade of elementary school	11	22
From 5th to 8th grade of primary	12	24

school		
High school incomplete	4	8
High school complete	12	24
Higher education incomplete	3	6
Higher education complete	2	4
Postgraduate	0	0

Which your occupation

Employee (signed)	18	36
Public employee contracted/employed	5	10
Self-	7	14
Retired / Pensioner	10	20
Unemployed	8	16
Widowed	2	4

Source: Data collected by the researcher (2019)

Regarding the surgical procedures, of the 50 participants, 46% (n = 23) performed orthopedic procedures, totalizing most of them. Then, General Surgery 24% (n = 12), Neurology 14% (n = 7), Oncology 10% (n = 5) and finally, Vascular 6% (n = 3) (Table 2).

According to January 2019 data from DATASUS, of a total of 299,608 beds available in Brazil for hospitalizations made through the Unified Health System - SUS, 37,497 are dedicated to general surgery patients, 14,309 orthopedic surgeries and 3,510 for oncological surgeries. No data were found for neurological surgery.

Table 2 - Data related to the surgical procedures and analgesic treatment prescribed after the surgical procedure.

VARIABLES	n	%
Procedure performed		
Orthopedics	23	46.0
General Surgery	12	24.0
Neurology	7	14.0
Oncology	5	10.0
Other	3	6.0
Analgesia (prescription drugs)		
Dipyrone	48	53.3
Tramadol	27	30.0
Morphine	8	8.0
Gabapentin	3	3.3
Paracetamol	3	3.3
Ketoprofen	1	1.1
TOTAL	90	100.00

Source: Data collected by the researcher (2019)

Fifty prescriptions were analyzed in the a total of 90 drugs were found, and the vast majority of the drugs were prescribed in combination, ie, multimodal analgesia. In this way, dipyrone 53.3% (n = 48), tramadol 30% (n = 27), morphine 8% (n = 8), gabapentin 3,33% (n = 3),

paracetamol 3.3% = 3), ketoprofen 1.1% (n = 1). (Table 2)

Konijnenbelt-Peters et al. (2017), shows that many studies report good efficacy of dipyrone as an analgesic in the postoperative period. Oral dipyrone has high bioavailability and is absorbed rapidly. A meta-analysis

shows that, following an oral dose of 500 mg dipyron, 70% of patients experience at least 50% pain relief in 4 to 6 hours.

The second drug used was tramadol, this data is in agreement with the study of Barros and Lemonica (2003), whose pharmacological properties make its use extremely relevant in different clinical circumstances, by understanding part of its analgesic action that is not dependent of opioid mechanism. Tramadol is a moderate opioid analgesic, making it always associated with a non-opioid analgesic with the purpose of achieving adequate analgesia.

The use of gabapentin has an efficient absorption, becoming a multimodal analgesia, bringing a decrease of pain and even use of smaller doses of opioids constituting a new vision in the therapy of postoperative pain. It is worth mentioning that gabapentin was used in subjects submitted to 3.3% of patients (CLIVATTI, SAKATA and ISSY 2009).

The union of drugs of different classes and with different means of action aims to achieve the expected analgesic effect with the decrease of some possible side effect. Multimodal analgesia, with an association of different classes of drugs, ie two or more drugs for pain or non-pharmacological interventions with different

mechanisms allows a more adequate effect. With this, the decrease of opioids that may cause side effects (LADHA et al, 2016 and CLIVATTI, SAKATA and ISSY 2008).

The use of a drug relationship that presents different mechanisms can increase the analgesic effect and reduce the side effects, thus minimizing the total amount of each drug (LADHA et al, 2016).

Analgesia can be established as the decrease or suppression of pain. Reduction of pain is seen as a fundamental human benefit and, as such, it is not only a clinical case, but also an ethical question that involves all health professionals. Pain afflicts millions of people around the world and is shown as the first reason for medical consultations (FERREIRA, et al, 2014 and MARTINEZ et al., 2011).

With reference to the preoperative cycle, the practice shows that patients who are properly oriented on the treatment and with the help of this knowledge during the hospitalization, tend to evolve in a distinguished way, with rapid improvement and excellent future results. In addition, all methods performed must be presented in such a way that the patient is actively involved in the established therapeutic plan, including their measures and possibilities (VITAL et al., 2018).

Table 3 - Pain intensity assessment according to pain scales Numerical visual range and range.

VARIABLES	n	%
Numerical Visual Scale (NVS)		
0 (without pain)	7	14.0
1	3	6.0
2	13	26.0
3	10	20.0
4	12	24.0
5	3	6.0
6	1	2.0
7	0	0.0
8	1	2.0
9	0	0.0
10 (maximum pain)	0	0.0
NVS per Range		
No pain	7	14.0
Mild pain	38	76.0
Moderate pain	4	8.0
Intense pain	1	2.0

Source: Data collected by the researcher (2019)

Because they undergo surgical procedures, pain has a high incidence among patients. Given the

complexity and subjectivity of the painful experience, analgesia control and its measurement becomes the first

challenge, and only the questioning of the patient does not adequately favor their evaluation, since not all will have conditions to report them, in a clear and effective way. It is clear that pain control still deserves greater care and attention in its evaluation by health professionals (BARBOSA et al., 2014).

The use of pain scales reflects a way of humanizing the care in which the patient's greatest interest is, taking into account what he describes and feels, and is therefore of utmost importance making the patient have the right to expression. This method is of great relevance for the planning of care in relation to the patient's pain and pathology, thus minimizing their suffering (BOTTEGA; FONTANA, 2010).

It was found in the present study that the incidence of complaints was high, inasmuch as 43 (86%) participants reported some pain intensity. In a similar study, a high incidence of pain was observed at the time of the interview (PIMENTA et al, 1992). Still with regard to pain, it was found that a greater number of patients presented mild pain, corresponding to 76% of the interviewees.

One should also consider the beliefs and psycho-emotional aspects of each individual that may influence the high incidence of mild pain. It is known that in some cases the patient may not even report the frequency and presence of pain due to cultural issues as well as issues related to the passive personality itself, which may be related to the findings of this investigation, in which the majority of patients reported pain of mild intensity (SILVA, 2007).

It was also noted that only 14% (n = 7) patients did not present pain during the interview, corroborating another study in which a small number of patients did not feel pain during the postoperative period analyzed (GIACOMAZZI and LAGGIO; MONTEIRO, 2005).

This result points to a relevant aspect: the confirmation that the pain accompanies the trauma caused by the surgical procedure. In addition, it also shows the magnitude of the pain intensity presented by the patients.

Regarding the number of analgesics prescribed by patients, it can be observed that 56% (n = 8) of the patients had prescription of two analgesics in their medical records. In addition, 100% of the participants had the prescription of at least one analgesic. It was not possible to observe a correlation between the type and number of analgesics prescribed, and the pain intensity. However, it is advised that the analgesic treatment be done in three levels, the first one being mild pain, the second, the moderate pain and the third, the intense pain. For level 1 NSAID prescription is indicated. For level 2,

the association of NSAIDs with weak opioids is indicated, and for level 3, the association of NSAIDs with strong opioids is indicated. As postoperative pain tends to decrease over time, its treatment should be initiated by the third step (SILVA, 2007).

In this respect, 32 (64%) were found to have opioid prescription. However, 2 (4%) patients who presented moderate pain had only NSAID prescription, demonstrating an inadequate analgesic prescription.

IV. FINAL CONSIDERATIONS

The results of this research indicate the need for systematic evaluation of pain in postoperative patients, aiming at its control, contributing to the recovery of these patients, since pain information leads to an increase in the synthesis of catecholamines and hormones, which released in an intense and prolonged way, can produce alterations in the organism such as alterations in the coagulation, reduction of the immune response, peripheral vasoconstriction, tachycardia, tachypnea increase of the arterial pressure, in this way delaying the recovery of the patient, also being able to occur the reduction of gastric emptying and predisposition to nausea, vomiting and reduction of intestinal tone.

It should be pointed out that some limitations of the present study can be pointed out, such as the fact that the sample is composed of 50 patients and because it was non-probabilistic, which compared to large specialized centers can be considered a very small number. However, such limitations do not compromise the results obtained in this research, since the statistical tests adopted ensure the reliability of these findings.

REFERENCES

- [1] BARBOSA, Maria Helena et al. Avaliação da intensidade da dor e analgesia em pacientes no período pós-operatório de cirurgias ortopédicas. *Escola Anna Nery Revista de Enfermagem*, v. 18, n. 1, p. 143-147, 2014.
- [2] BARBOSA, Maria Helena et al. Dor, alterações fisiológicas e analgesia nos pacientes submetidos a cirurgias de médio porte. *Revista Eletrônica de Enfermagem*, v. 16, n. 1, p. 142-50, 2014.
- [3] BARROS, Guilherme Antonio Moreira de; LEMONICA, Lino. Considerações sobre analgesia controlada pelo paciente em hospital universitário. *Revista Brasileira de Anestesiologia*, p. 69-82, 2003.
- [4] BOTTEGA, Fernanda Hanke; FONTANA, Rosane Teresinha. A dor como quinto sinal vital: utilização da escala de avaliação por enfermeiros de um hospital geral. *Texto & contexto enfermagem*, v. 19, n. 2, 2010.
- [5] CALIL, Ana Maria; DE MATTOS PIMENTA, Cibele A. Intensidade da dor e adequação de analgesia. *Revista Latino-Americana de Enfermagem*, v. 13, n. 5, 2005.

- [6] CLIVATTI, Jefferson; SAKATA, Rioko Kimiko; ISSY, Adriana Machado. Revisão sobre o uso de gabapentina para controle da dor pós-operatória. **Revista Brasileira de Anestesiologia**, v. 59, n. 1, p. 87-98, 2009.
- [7] DELLAROZA, Mara Solange Gomes; PIMENTA, Cibele Andrucio de Mattos. Impacto da dor crônica nas atividades de vida diária de idosos da comunidade. *Ciência, Cuidado e Saúde*, v. 11, n. 5, p. 235-242, 2012.
- [8] FERREIRA, Neuza et al. DOR E ANALGESIA EM DOENTE CRÍTICO-PAIN AND ANALGESIA IN CRITICAL ILLNESS. **Revista Clínica do Hospital Prof. Doutor Fernando Fonseca**, v. 2, n. 2, p. 17-20, 2015.
- [9] GIACOMAZZI, Cristiane Mecca; LAGNI, Verlaïne Balzan; MONTEIRO, Mariane Borba. A dor pós-operatória como contribuinte do prejuízo na função pulmonar em pacientes submetidos à cirurgia cardíaca. **Revista Brasileira de Cirurgia Cardiovascular/Brazilian Journal of Cardiovascular Surgery**, v. 21, n. 4, p. 386-392, 2006.
- [10] KONIJNENBELT-PETERS, Jorieke et al. Metamizole (Dipyrone) as an alternative agent in postoperative analgesia in patients with contraindications for nonsteroidal anti-inflammatory drugs. **Pain Practice**, v. 17, n. 3, p. 402-408, 2017.
- [11] LADHA, Karim S. et al. Variations in the use of perioperative multimodal analgesic therapy. **Anesthesiology: The Journal of the American Society of Anesthesiologists**, v. 124, n. 4, p. 837-845, 2016.
- [12] MEIER, Alcione Carla et al. Análise da intensidade, aspectos sensoriais e afetivos da dor de pacientes em pós-operatório imediato. **Revista Gaúcha de Enfermagem**, v. 38, n. 2, 2017.
- [13] MIGUEL, J. P. A dor como 5º sinal vital: registo sistemático da intensidade da dor. **Circular normativa N°**, v. 9, 2003.
- [14] MINISTÉRIO DA SAÚDE (BR). DATASUS. **Leitos de internação – Brasil** acesso em 10 mar 2019. Disponível: <<http://tabnet.datasus.gov.br/cgi/tabcgi.exe?cnes/cnv/leiintb.r.def>>
- [15] PEREIRA, Lilian Varanda; SOUSA, Fátima Aparecida Emm Faleiros. Mensuração e avaliação da dor pós-operatória: uma breve revisão. **Rev. latinoam. enfermagem**, v. 6, n. 3, p. 77-84, 1998.
- [16] PIMENTA, Cibele Andrucio de Mattos et al. Dor: ocorrência e evolução no pós-operatório de cirurgia cardíaca e abdominal. **Rev. paul. enferm.**, v. 11, n. 1, p. 3-10, 1992.
- [17] SAÇA, Camila Simões et al. A dor como 5º sinal vital: atuação da equipe de enfermagem no hospital privado com gestão do Sistema Único de Saúde (SUS). **J Health Sci Inst**, v. 28, n. 1, p. 35-41, 2010.
- [18] SAKATA, R.; ISSY, A. Nomenclatura e classificação da dor. **Guias de Medicina Ambulatorial e Hospitalar/Unifesp-Dor. 2ª Ed. Barueri, SP: Manole**, p. 1-4, 2008.
- [19] SILVA, Magda Aparecida dos Santos. **Efeitos da intervenção treinamento, avaliação e registro sistematizado no controle da dor pós-operatória de cirurgia cardíaca**. 2007. Tese de Doutorado. Universidade de São Paulo.
- [20] TEIXEIRA, Patrícia Araújo Pinto et al. Manejo da dor pós-operatória: uma revisão bibliográfica. **Revista de Medicina e Saúde de Brasília**, v. 3, n. 1, 2014.
- [21] VITAL, I. C. et al. Informação como instrumento da assistência ao paciente submetido a cirurgia ortopédica. **Cogitare Enferm**, v. 23, n. 1, p. e51192, 2018.

Youth and Transitory: The Profile of IRPAA Residents and the aspects of their Training

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Abstract—This article aims to broaden the specificity of the historical approach that revolves around the discussion of "student republics" and "youth", as well as to develop theoretical/methodological considerations about the youth condition experienced by these young people. Ten (10) collaborators are used methodologically, with six (6) young people living and four (4) living in a student republic maintained by a non-governmental organization located in the city of Juazeiro, Bahia, where offer training opportunities in the context of living with the semi-arid region, which contrasts with the technical and vocational training under which they are subjected. It presents as main results the reflection that these young people who are of different origins, whether from the countryside with traditional bases (indigenous people, quilombolas, fishermen, family farmers, relatives, pasture fund, social movements, etc.) being the result of the process of construction of the subject, based on the juvenile hybridity, influenced by the transient movements, which is the main challenge to think about and propose formative processes that meet the specific needs of these subjects, whether in the educational field, social movements and / or human ecology.

Keywords—Training, Juvenile hybridity, Transient movement, Narratives.

I. INTRODUCTION

This article is an integral part of the master's dissertation produced in the Postgraduate Program in Human Ecology and Socio-Environmental Management, which is interested in discussing the relationships established by young people in their vocational training process and their future performance. These subjects live in a student republic maintained by a non-governmental organization located in the city of Juazeiro, Bahia, where they offer training possibilities in addition to their stay in the context of the semiarid coexistence. which are submitted.

Thus, the present work aims to broaden the specificity of the historical approach that revolves around the discussion "student republics" and "youth", especially when compared to the interdisciplinary approach, as well as develop some theoretical / methodological considerations about the condition young people lived by these young people, in which we are considering "transient youth" from the experience since its origin in the field and the relationship established by studying and residing in the Republic of the IRPAA.

Given this presupposition, the text in evidence takes as its centrality the displacements carried out by these young people in relation to the departure of their community and the arrival in formative spaces that are also linked to daily living and the relationships

established by it and constituting other horizons for their lives. We call this movement "transitory" and seek throughout the text to problematize this place of formative reconstruction for the life of young people.

As mentioned, the formative process is also due to the coexistence in the republic, so it is pertinent to signal that this terminology has several meanings and meanings, but the applicability in this text is synonymous with the hostel, boarding house, ticket house, student house. This definition is not demarcated by a specific date for its emergence, but, many scholars, link the first universities of Portugal and the houses created by the government of the same period. With Portuguese influence, Brazil had its first student republics in the state of Minas Gerais and spread in several capitals and interior of the country.

However, a model with characteristics different from traditional ones was created over 20 years ago in the interior of Bahia, in the region of the São Francisco valley, in order to provide non-formal training and enable the children of farmers to continue their studies, mainly technical training.

With a transition dynamic through which young people are submitted (coming from the countryside, going through technical training, going back to the field, and returning to the urban area in the majority), it causes us to think of a different condition experienced by them and

that reflect the formation, participation and professional constitution, the condition of transitoriness, which has contributed to the development of the rural and its communities, in a fair and sustainable way, thanks to the dynamics of the republic and the influences of the formative processes.

The discussion on "youth" has a vast conceptual field, in which its definition varies from biology, sociology, anthropology, political sciences, among other areas of knowledge, more basically the youth is understood as a phase in which the individual is in development, where spaces, orientations, positions, and conceptions, will define this subject, which is in constant changes and transitions.

The understanding of the conception of youth, in this case, is bound up with the factors and the cultural, social, customs or traditions perspectives in which this subject is inserted, where any result, whether harmonious or disharmonic, will result in a product distinct from so many others, however rich in meanings and subjectivity.

Still discussing in the epistemological field of the young subjects, the Food and Agriculture Organization of the United Nations considers that

There is no universally accepted definition of youth. Young people have been described in many different ways; sometimes as a particular age group, as a stage of life or as an attitude. [...] In its relations with governments and organizations, FAO uses a wide range of ages, depending on the specific definition of "youth" used within a particular country or a specific organization. The age range surprisingly ranges from 8 to 40. (FAO, 2002.)

Like the FAO and the UN, there is no concrete definition, just a concrete discussion as regards the age group for its definition "The UN Secretariat uses the terms youth and young people interchangeable to mean age 15-24 with the understanding that member states and other entities use different definitions".

However in the same discussion, there are exceptions, where in some countries they will have their standards, but in Brazil, there is a divergence, where several regiments, documents and institutions have their own definition of age group and arguments. The Statute of the Child and Adolescent - ECA, between the ages of 12 and 18 is incomplete, the National Youth Statute, from 16 to 29 years of age, and finally the Brazilian Institute of Geography and Statistics - IBGE and some governmental programs linked to agrarian reform establishes between 16 and 24 years of age. Just as in some countries and not

different in Brazil, youth is a more fluid category than a fixed age group.

It is important to highlight that methodologically this work consists of the construction of a diary of the daily experience of formation, memorials, interview narratives and interviews by depth, in order to build the profile of these young people. In order to maintain ethics, research confidentiality and shelter employees, we will use codenames of birds and fish of the caatinga, in order to maintain the climate and valorization of the natural context and to remember the transitional character of these animals, characterized by their comings and goings, in some migratory cases.

Thus, initially, we will discuss the paths and transitoriness of the young people's constitution, theorizing the identity steps throughout history and the constitution of the different youths, then we present the discussion that revolves around the republics, from its genesis, the terminological association to inns, exposing the history and types of republics (outside and within Brazil), reaching the model of republic located in the semi-arid Bahia. Finally, we present the perspective of transient youth, based on the institutional profile, through the voices of these young people.

II. TRANSITORY AND THE CONSTITUTION OF YOUNG PEOPLE

Youth can be seen in a number of different ways, which result in different youth policy strategies. Views of this period can be split into different phases. Youth can be seen as a transitional phase, a socialization phase, a struggle for social status or as a period with intrinsic value. There are differences between the different views, but they should not be exaggerated (YOUTH AND YOUTH POLICY – A SWEDISH PERSPECTIVE, 2010).

The citation in evidence, a fragment of a Swedish reference text, "Youth and Youth Policy - A Swedish Perspective," sums up, in a nutshell, the universality of youth and its multiple definitions, the same is a result of militant young people together with the Swedish National Council for Youth Affairs, which ensures that young people have access to influence and well-being. Thus, in this topic, we will discuss the concept of the word youth, which is a subject that is constantly discussed, mutated and present more and more in academic circles. We will try to make a genealogy about the historical conditions that have arisen on this subject. Considering the historical aspects and cultural partners trying to understand how this concept transpires to practice.

Many historians claim that youth as a social class only arose in the eighteenth century, Dick (2003) points out that the term juvenile was only officially categorized in this century where it definitively marked its limits in the history of mankind. Being interesting to transpose to make a provenance on the youth category for the understanding of some subjective elements contextualized in our western culture.

In the history of Ancient Greece, we understand how it initiated the obstacles of the Western structure in the way of thinking, organizing in society and of relationship. In the book *The Story of Young People*, a text by Alain Schnapp (1996) points out that for the Greeks cities were synonymous with a regulated social life. The Greeks treated young people as beginners in civic life, and everything concerning the polis was dealt with from the oldest to the youngest, with the basic conduct of Hellenic life as the ideal of beauty (pederasty, homosexuality) and war (the hunting games and physical exertion). Defining youth in this age as the beautiful and the strong are firmly establishing in their own body the most fundamental situations of their own life. Yet within this context, there is a counterpart with philosophy as names of Socrates and Plato that revolutionized Greek education and way of life.

Nietzsche, Socrates, and Plato bring a dualist interpretation of the world to explain the meaning of life and establish hierarchies of principles and values. Nietzsche (2001) brings a vision of Socrates on moral inversion, which creates a therapy to harmonize the Greek instincts giving particularity to the figure of the young. Finding it necessary to discipline the young man. Using this dialectic for the principle of self-assertion as an advent of defense, transforming the rule of beauty and strength into reason, virtue, and happiness. Passing everything by the evaluation of reason. Thus, in the face of two points of view of the cultural transformation of the beautiful and the force of human reason, we come to a new phase of Western humanity, opening a door to an interpretation of the construction of youthful subjectivity.

When we go to Christianity, we note that it springs from the context in which Greek culture is being transformed from the dialectic of Socratic reason to being apprehended by the Roman empire that later incorporates Christianity into its social scene as an official religion.

Christiane Marchello-Nizia (1996) points out that in the average age most heroes are young, or at least men with juvenile qualities. And when we look at the literature of this time we identify principles linked to love and prowess (chivalry and courtesy). Understanding that the values attached to young people in this stage of history are linked to the battlefield and cloister of the

monasteries. Society was centered on religious and educational institutions that focused on controlling the juvenile carnal passions that emerged most at this stage and the body was seen as an object of desire, in short, a culture turned to moralism.

Thus epistemologically we can define the word youth from several strands. By biology, it is understood in two initial stages: pre-adolescence (from 10 to 14 years) and adolescence (from 15 to 19 years). For sociology, youth is constituted as a young insecure aspect within the contemporary scenario of the future. Anthropology sees youth as an enriching cultural element. And history treats youth as a temporal, spatial and cultural variant depending on the society inserted (CLIMACO, 1991). The juvenile trajectories in the country came from the abolitionist movement in the XIX century, these young people intervened in the radical action for the liberation of the slaves (CACCIA - BAVA, 2004). In 1920 three movements in favor of political youth were inaugurated: the Movement of the Week of Modern Art; the Tenentista Movement and the political party movement that originated the PCB political party. According to Caccia - Brava (2004: 64): "Youth groups were formed around these movements and were protagonists of new ideas, new conceptions of nation and state".

We then had a youth organization with movements focused on nationality as a highlight the National Student Union - UNE and the religious movement around Catholic Action. According to Novaes (2000), the youths who belonged to the partisan and union organizations represented the working class. Highlighting the decade of 1960 that was when the youth began to have an emphasis on Brazilian society. But due to the political effervescence of the years that followed from the 60's because of the Military Dictatorship, the youth exerted an internal articulation of a spiritualist nature, and the young people who resisted this system acted in the clandestine social movements of armed struggle.

In the pre-1990s we come across a youth that is not utopian, according to Sousa (1999): "Intentions, utopias, projects, rebellions, transgressions are concrete elements in the relations lived by this age group, but isolated as behaviors of the young, is not explanatory of the relationships involving the youth" (IDEM, 1999, p.25). The social conditions of the youth of the 1990s are distanced from revolutionary methods, and what is noticed is an individualistic perspective.

As already mentioned, there is no exact universal age group to delimit this phase of life, so, as already mentioned, the most cited is used by various territories is between 15 and 24 years based on UNESCO and

especially the UN, "Youth and Young People, The UN Secretariat uses the terms youth and young people interchangeable to mean age 15-24 with the understanding that member states and other entities use different definitions (UN, s / d)", as mentioned, there will be cases in which the country or continent, will define on the basis of its statutes or regiments the initial and final age.

As previously mentioned, in relation to age range variations, in South Africa, the age group is between 14 to 35 years (OAU, 1996); in Canada, there are variations based on their geographical variations from 12 to 19, or in some cases from 15 to 19. The British say that there is no exact starting age but ends at 30 years. In Japan, young people are individuals up to 35 years of age (Chaves, 1999).

In other Western countries, they define the maximum age of youth for 15 years of age, but this will depend on the cultural aspects of each nationality. Youth is a category that in addition to being marked by adversity is a dynamic class. And from a new family, political and social conjuncture, the young person is inserted in a transitory society process.

However, some experts (PAIS, 2003; OLIVEIRA, 2014) consider youth as the transitions phase, the intersection between the responsibilities of children and adults in society, that is, assume a social role, going beyond an age group. However, official bodies such as the IBGE, determine from 15 to 24 years. The Youth Statute (BRAZIL, 2013) considers young people in Brazil to be all citizens between the ages of 16 and 29 and finally the Statute of the Child and Adolescent (ECA) establishes that adolescents are individuals between 12 and 18 years of age. In this way, we can consider some variants, divided into three stages: teenagers (between 15 and 17 years), young people (aged between 18 and 24 years) and young adults (25- 29 years old).

Completing the discussion and giving continuity, youth can be defined by their cultures, beliefs, ideologies (ideas, thoughts, doctrines, and worldviews) and origins (rural, urban and rururbano), or even by periods (golden years, hipers, painted faces, etc). that is, "[...] youth is a symbolic conception, representation or creation, made by social groups or by individuals considered as young, to signify a series of behaviors and attitudes attributed to them. (GROPPO, 2000, p.07).

Young people are living in constant changes and adaptations, inserted in a globalized / technological context that encompasses the fourth industrial revolution, with the use of computers, tablets and cell phones of last generation that end up canceling distances that previously

existed and giving access to all the types of information either for the field or for the city. "... because of its combination with other social situations - such as class or social status - and also due to cultural, national and local differences, as well as to ethnic and gender distinctions" (IDEM, 2000, p.15). Thus, mainly rural or rural youth, which was formerly marked by "ignorance" denial of rights, now traces a path of development in education, culture, and leisure.

It is known that there has always been the context of the exodus to the great centers in the longing for a better condition of life. In the youth field, we are currently seeking an insertion as a singular subject in its identity and plural constitution in its particular needs and thus we identify as transitional young people.

Aiming to broaden the discussion and enter the universe of the transience of young people, especially young people from the countryside and migrate to the urban in search of study/work, the new housing, where they have often shared environments, contribute to the construction of the identity of these subjects.

Life in the Republic: from the transitional to the social subject

The origin of the term "republic" has a genealogy of the Latin *res publica*, a word that can be expressed as a public matter or public thing, which denotes the idea of a public good, of what is collective (LAFER, 1989). The regime approached by the Roman Empire was also used to classify the city-states of Greece, or the regime instituted by Oliver Cromwell in the seventeenth century in England (MENDÉS-FRANCE, 1963). However, the modern conception of the republic (based on a head of state and the division of powers) only arose after the strengthening of liberalism.

Thus, republican terminology has gained adjectives and has been associated with student housing, student houses, boarding houses, pension or Brotherhood, however there are several assumptions (REPOLÊS, 2007), so these types of housing are composed of groups of young people, mostly of the times they are from distant localities and move in search of study (MACHADO, 2013a).

With regard to the first records on republics, there are several versions, the most cited being that in the fourteenth century in Coimbra, Portugal, when D. Dinis, by royal diploma of 1309, required the construction of houses should be inhabited by students in the area of Almedina, by means of a fixed payment of a rent, administered by a commission appointed by the King, composed of students and "good men" of the city. In this way, these types of accommodation made possible the

universality of higher education, allowing young people from various localities to continue their studies.

Already in Brazil, the student republics have their origin from the first faculties created in the regency of Dom João IV, such as the Faculty of Medicine in 1808, more ahead with Dom Pedro II, with the implementation of the School of Mines in Ouro Preto in 1876, became the center of student life, incorporating tradition, history and customs (IDEM, 2013c). Thus, near the School of Mines, student republics were created, in the same models as those in Coimbra, noting that the houses were owned by the School, with the change of capital to Belo Horizonte in 1890, and the responsibility and maintenance of students, assigning a small rent. (IDEM, 2013b).

In this way, the republics of Ouro Preto in Minas Gerais are called unique in Brazil (MALTA, 2010), thanks to their peculiarities, said to be unequalled to other university cities, having the characteristics of student dwellings, with their tradition, history, and constitution of structure, similar) to the republics and solar of Coimbra, in Portugal.

Other relevant information for this discussion is the creation of the first republic outside the country, destined to the Brazilian students in Paris, called "house of the students" created in 1928, located in Paris, and directed to assist students studying in the capital of France and had difficulty staying in the city (COSTA, 2010).

With the passage of time, the student republics have been multiplying over the years and Brazilian territory, adding the most diverse types of education, from elementary and secondary education, an example from the perspective of the pedagogy of alternation, as well as technical education offered by technical schools and federal institutes and, finally, in the higher education, from state to federal institutions, in which

[...] some units of university residences, where all the infrastructure was made available, such as furnished rooms and appliances, while in others it is a grant destined to the payment of housing expenses with varying amounts (IMPERADOR, 2017, p. 295).

Thus, there is a diversity of types of republics, in which part of them are part of the student assistance plan, where the institutions offer housing (inside or outside the institution) maintained by the same and in another case, the houses are maintained by the students themselves with the help of family assistance or help. Thus the republics or housing destined to young people of other localities that go in search of continuing their studies, they have been in Brazil and for centuries and lately has extended and gained the interiorization in diverse regions and states.

A model of a republic, located in the semi-arid state of Bahia, which has been in existence for more than two decades and annually receives groups of young people from the countryside and traditional communities, who migrate in search of continuing their studies, for the regional and local development of the subjects' communities. Being the host, the centrality of this study, since it has unique characteristics of the models described throughout this material, giving rise to a term called Transient Youth, which will be detailed later.

To enter the context of the republic that we will discuss, we initially introduce the institution that administers the same. The IRPAA, or rather, the Regional Institute of Appropriate Small Farmers, founded almost 30 years ago, is a non-governmental organization based in the municipality of Juazeiro-BA, which develops awareness-raising and awareness-raising activities through educational projects and concrete actions to the coexistence with drought is the semi-arid (OLIVEIRA, 2005; CARVALHO, 2008; OLIVEIRA, 2014).

Once, the IRPAA became a reference in studies and training, to coexist with the semi-arid region, it was necessary, the expansion of its facilities as well as the creation of a center for the accomplishment of the formations, so in 1994, the center was created Dom José Rodrigues or popularly known as the IRPAA farm, located 12 km from the city of Juazeiro-BA, in the Jardim Primavera district on the 30-hectare Tourão farm, the area has an auditorium, dormitories, dining room, as well as experiments various types of cisterns, processing plant, vegetable gardens, animal husbandry, Barreiro, etc.), all this structure is the basis for various events (meetings, seminars, conferences, etc ...), and can accommodate up to 60 people .

In addition to the prospect of a training space, the institution added the farm to a republic formed by two houses (female and male), destined to receive youngsters from the countryside, children of farmers from several Brazilian semiarid localities , which have partnerships with partner institutions that seek to enter technical or higher courses in the agrarian / environmental area. On the other hand, the institution offers an informal formation in several areas and abilities, aiming to develop the critical, political sense for new horizons and especially for the conservation and coexistence with the caatinga and semiarid biomes.

The maintenance of the countryside and the republic are carried out by the young residents, who carry out conservation activities such as cleaning, weeding, feeding, composting, among other activities, at times that do not jeopardize their studies. The source of support in

the institution is through sponsorship scholarships (SILVA, 2004, p.27), to keep personal costs and not to induce young people to seek work and focus only on studies. In addition, in signing the agreement with the IRPAA, an agreement is made with the youth, in which, after completing the course, they must return to their communities and during a period, they must make a return, as it is presented in some narratives of the following employees:

"[...]por outro lado, eu estava com a formação técnico em agropecuária, então meu pensamento foi que, ali seria o momento em que eu iria voltar para minha terra, pra contribuir[...]" (PACUMÁ, memorial de formação, 2018).

"[...] o acordado entre o IRPAA e a instituição que nos indicam, que no final do curso técnico, retornamos para repassar os conhecimentos e aplicar em nossa comunidade, [...]" (DOURADO, diário do cotidiano., 2017).

The republic supports 24 young people at the most, who make casters to visit their communities, especially on commemorative dates, to visit relatives. Thus, every year a new group arrives and another leaves the institution. In this dynamic of comings and goings, with the fixation of a period in the communities, they generate a transience, in which I denominate of "transitory youths". Thus over more than 23 years, more than 150 young people have passed, who have a group and a generation, with great responsibility for the development of their bases.

Who are the young residents of IRPAA: aspects of transitoriness and training

The northeast region is known for its great territorial extension, besides sheltering most of the Brazilian states, a region rich in cultural, climatic and geographic diversity, has a great variety of biomes, among them the Atlantic forest and mangrove (littoral), Amazon forest (west of the region), forest of cocais, closed and with greater extension and predominance the ecosystem with characterized semi-arid, called caatinga biome, in which an image and stereotyped visions have been always transmitted mainly in the interior and in the field, of a place of delay and miserable people, illiterate and malnourished, cracked ground, dead animals, with a belief that nothing was right here, for it was the will of God. With only one direction remaining, they migrated to the cities, which were synonymous with progress and modernization, and for decades, especially in the great droughts, thousands of northeasters sought the metropolitan regions, especially in the southeast, as an alternative to get rid of the droughts.

With this, several actions and programs were implemented by governments, aiming to eradicate and combat drought, such as DNOCS and SUDENE, among others, but the actions saw that the drought was something negative and should be stopped at any cost, not seeing that is a natural phenomenon of this region. Thus, in the last three decades, actions have been taken to coexist, in particular with civil society organizations, social movements, family farmer organizations, peasants and leaderships (COSTA, 2017), creating a new paradigm in logic of the Coexistence with the Semi-Arid, which assures the perspective of the Good Life, through a sustainable relation of human beings and nature "(IDEM, 2017.p. 95)

The initiative to create the institution was given by Bishop José Rodrigues of the Diocese of Juazeiro, who followed the ideals of living well, and against some governmental proposal (against drought), as well as militant for the causes of the least favored in the field and in the city, in which organizations and international cooperation together with the Community Ecclesiastes of Bases - CEB's, initiated a collective of local and regional actions, with the aim of minimizing the consequences of the prolonged drought.

In this context, in April 1990, the Regional Institute for Appropriate Small Farmers - IRPAA, an organized, nongovernmental and nonprofit civil society organization legally ruled by an association, with representatives of dioceses, farmers and regional leaders, which at first draws on the experiences and ways of life of rural communities and, in the first instance, formulates a different proposal for this region, based on local knowledge, identifying potentialities and fragilities, learning from nature to deal with the adverse situations of climatic oscillations, respecting the local specificities, valuing the culture of a strong and resilient people, people of great faith and belief, that even with the marked rural exodus, still hopes for better days in the countryside.(COSTA, 2017, p.88-89)

With the creation of the IRPAA, several aspects related to the coexistence with the geographical, biological and climatic context, began to be seen in other ways, from "wretched drought" to "a climatic reality in which we must live and seek means to survive" this is the mission and militancy of the IRPAA, organized in three periods (1990-1999, 2000-2009 and finally 2010-2017) of the institution's actions since its inception,

1. Between 1990 and 1999: institutional strategy was the construction and dissemination of the proposal of Living with the Semi-Arid (IDEM, 2017, P.89);

2. Between 2000 and 2009: in defense of an appropriate public policy for the Semi-Arid (IDEM, 2017, p.93).
3. Between 2010 and 2017: a strategy under construction today, it runs through the Consolidation of Coexistence with the Semi-Arid (IDEM, 2017, p.94).

Returning to the previous subtopic, with the creation of the IRPAA, the training center Dom José Rodrigues (initially named only as an IRPAA site, in honor of the founder, is now named) was added to the physical spaces as a structural part of the where it serves as a laboratory and training center for the coexistence with the semi-arid. Taking advantage of the space, in addition to the international initiatives, the creation of a republic aimed at receiving the children of farmers and traditional peoples was implemented in the same space, in order to continue the studies (technical and University graduate).

Over 24 years (1994-2018), hundreds of young people passed through the republic of the institution, sharing and disseminating the principles and ideas for coexistence with the caatinga biome, between comings and goings, trebled and guided a Good Living mission. For the construction of this research, ten collaborators participated, among them six young people residing in the republic and four who lived and went through the process of formation.

The following are the collaborators, using codenames to guarantee the research ethics and protect the subjects. For this moment, we will use excerpts from the diary of daily training experience, memorials and narrative interviews and by depth, for their presentation. For this, we will use names of species of fish and birds of the caatinga, since they are animal synonyms of resilience, strength and its transitional character of comings and goings.

Initially we present the students Tiziu, Asa-Branca, Surubim and Pacumã, you can observe that this one has as similar the passage and experience in the republic and the constitution as professionals starting from these experiences.

Natural de uma comunidade rural chamada Lagoa da Roça, município de Campo Formoso na Bahia e criado pelos avôs maternos, desde cedo fui instruído a participar dos espaços religiosos, igreja católica, e espaços coletivos de discursões na comunidade, associação comunitária, além do envolvimento nos trabalhos da roça onde plantávamos feijão, milho, mandioca, batata, guandu, abobora, melancia e nos dias de sábados íamos vender esses produtos na feira livre do município.” (TIZIU, MEMORIAL DE FORMAÇÃO, 2018)

Eu Asa Branca, 35 anos, filha adotiva de pequenos agricultores camponês, Maristela Santos de Santana e Edmundo Ferreira residente e domiciliada na comunidade Itapicuru Monte Santo Bahia, venho através deste relatar minha trajetória de vida pessoal e profissional. [...] desde muito cedo, quando ajudava meu pai nos trabalhos da roça e participava dos acontecimentos e iniciativas populares junto a minha mãe professora, líder comunitária e defensora de uma classe oprimida, a qual tanto almejava um grande sonho, juntamente com varias tantas outras lideranças dar-nos, apoiar-mos enquanto filhos de agricultores(as) do campo uma educação qualificada que defendesse e discutisse a realidade, a vida do jovem camponês. (ASA-BRANCA, MEMORIAL DE FORMAÇÃO, 2018).

eu sou Surubim , tenho 24 anos, acidente geográfico Chorochó-Bahia, Escorpiana, carrego comigo sangue indígena, mistura com mulatos, minha biza era índia os trukas, técnica em agropecuária, mãe do Miguel, venho da comunidade Alto Vermelho município de Abaré, BA, comunidade qual é reconhecida como fundo e fecho de pasto, filha de agricultor e agricultora, venho da luta, fiz parte dos movimentos sociais, fiz parte também do grupo gau: grupo de agroecologia Umbuzeiro, que fina na Universidade ENEB/Juazeiro, em 2014 fiz parte da república do IRPAA (SURUBIM, MEMORIAL DE FORMAÇÃO, 2018).

Sou Pacumã, sou filha de agricultores familiares, minha mãe e meu pai, sempre trabalharam na roça, assim como os meus avôs, tanto materno como paterno, [...] meu pai sempre trabalhou na roça, tanto na cultura do cajueiro, [...], eu não tinha condições de ir e nem me manter naquele momento, pois no primeiro ano não teria a bolsa [...] meu tio avô, disse que me ajudaria naquele momento, [...] meu tio e minha mãe me deram apoio [...] eu fui com meu primo e um colega da comunidade [...], que também fizeram parte da república [...] (PACUMÃ, MEMORIAL DE FORMAÇÃO, 2018).

In narrating and presenting themselves, the young people make a movement to meet the various temporalities that constitute them and are signifying the dimension of transience that we are referring to throughout the text. We will continue presenting the narratives of the current students who live in the republic of the IRPAA and composes the transitory movement in these subjects and their spaces.

Desde à infância, fui menino de igreja, menino comum, igual a todos mas, religioso, isso se deve ao incentivo de minha mãe, embora não muito religiosa, sempre levou-me à encontros de grupo, reuniões das quais participava, tudo isso ligado à igreja Católica. [...] até fundador de um grupo de

oração e outro de canto e sendo membro de um grupo de Jovens. [...]Canudos; cidade histórica, [...]cidade de gente simples e acolhedora que mesmo com influencia midiática e com as políticagens partidárias, tentam manter o espírito de fraternidade (CABURÉ, DIÁRIO DO COTIDIANO..., 2017)

Sou da comunidade Caraiba de Senhor Teixeira, município de Pilão Arcado em minha comunidade mora só família tem seis casas. Praticamos atividades voltadas a agricultura e pecuária onde criamos gado, ovelhas, cabras, galinhas, produzimos farinha, tapioca, etc. o que me trouxe a esse curso foi a necessidade técnicas em agropecuária em minha região além de ser uma área que me identifico[...]. Na minha comunidade eu trabalhava como catequista e nas comunidades vizinhas por a igreja católica participava de encontro que era promovido por a paróquia Santo Antônio em Pilão Arcado onde vinha jovem do município todo no centro de formação Palmeiras de Elim onde tinha encontro de estudos de bíblia, assembleias entre um espaço muito agradável[...]. Também sempre gostei de participar de reuniões de associações ou qualquer do tipo. Sempre participei de reuniões promovidas pelas entidades IRPAA e SASOP[...].dos encontros promovidos pela pastoral da Terra-CPT que também me ajudou a escolher cursar agropecuária onde eu já tinha conseguido um vaga para estudar na EFAS de Monte Santo[...](PIAU, DIÁRIO DO COTIDIANO..., 2017)

Sou azulão, venho do interior de Campo Formoso, tenho 21 anos (Jardel), filho[...], tenho duas irmãs[...].ambas mais novas. Mãe é dona de casa e também trabalha na roça, pai trabalha em construção civil[...].terminei os estudos em 2014 foi quando comecei a trabalhar mais meu pai, na construção civil. Trabalhei dois anos com ele. [...] venho de uma família simples do interior de campo formoso, onde fui criado pelo meus pais com a ajuda de meus avós paterno, uma infância um pouco difícil por não ter condições financeiras[...], fiquei sabendo do IRPAA através do meu tio que, morou na república. (AZULÃO, DIÁRIO DO COTIDIANO..., 2017)

Sou arribaçã, tenho 21 anos e venho de uma comunidade indígina da tribo tuxi do município de Abaré-BA. Ainda sou agricultora, índia e atualmente estudante do curso de engenharia agrônômica e filha de agricultores na qual o principal sustento foi o manejo com a mãe terra, desde aos 11 anos comecei com trabalhos de grupos na igreja de minha comunidade e logo depois com o passar do tempo com a causas indíginas do meu povo tuxi. (ARRIBAÇÃ, DIÁRIO DO COTIDIANO. 2017).

Sou carcará, de uma comunidade quilombola, [...] do povoado de Tamandua, [...], tenho orgulho de ser remanescente de quilombola de um povo resistente, lutador que mesmo com o sofrimento conseguem manter-se forte e luta por seus direitos, que durante muito anos foram negados[...](CARCARÁ, DIÁRIO DO COTIDIANO..., 2017)

Meu nome é dourado, tenho 20 anos,[...] somos 3 irmãs,[...] já moramos em Brasília por oito anos e voltei em abril de 2008, foi quando terminei a 4ª série, em Lagoa de Eduardo, comunidade de Pilão Arcado, mais eu moro em sítio Geraldo,[...] porém tive que repetir de ano, pois minha mãe achava que não estava preparada para a 5ª série[...].das três irmãs, uma faz pedagogia, e a mais nova esta parada, pois mão não tem condições de pagar,[...] a minha vinda para IRPAA, foi graças a colega, que estuda em Monte Santos, na EFA, que é da comunidade, que falou, [...] eu era secretaria da associação, [...] ai o gerente pastoril me indicou a associação de fundo de pasto, que me indicou, [...] eles viram o meu envolvimento na comunidade,[...] antes de vim, eu estava preocupada, vou terminar o ensino médio e vou fazer o que,[...]os professores perguntava o que a gente ia fazer, qual faculdade, mais a gente não sabia[...]. (DOURADO, DIÁRIO DO COTIDIANO..., 2017)

As seen, a good part of those who have lived or lived in the republic have some common characteristics, among them the origin of social movements, traditional communities (countryside, fishermen, natives, quilombolas, farmers, among others) or relationship with the church or related groups. Given that all share ideals, customs, cultures, habits and practices, aimed at a sustainable and ecologically correct culture, so those involved with the Republic are constantly training, mainly informal and non-formal, due to diversity the coexistence and the policies of the institution.

It is these aspects that make it possible to think of transitional young people who are initially constituted by the profile traced by the institution when creating inclusion criteria, based on the internal regiments, terms of adhesion. These young people come from traditional communities, be they fishermen, quilombolas, natives, pasture fund, families that live from fruit extractivism, family farmers

However, there are exceptions, some young people who passed through the republic were indicated by social movements, linked to the church, as the case of the young Caburé, who comes from the municipality of Canudos-BA, by indication of the Catholic Church and CEB. thus, the criterion of being of small municipalities, with a

culture / commerce directed to the field, where some scholars, show that the expansion of these spaces, gave origin to small villages, and in turn, in small municipalities, in which, it is still a developed rural environment, as some authors often call urban-rural (BERNIERI, 2002; REIS, 2006). Thus, for this study, the young people of the republic are always associated with the field, since the centrality, besides the processes of formation, is destined to this subject profile.

Transient movements and young people as a social subject

the juvenile phase is characterized by a gradual transition to the full assumption of adult roles in all societies, both rural and urban (DURSTON, 1994, p.14)

The movement of going and coming from the countryside to the city and vice versa is composing a hybrid process of identity constitution in these subjects, often leading them to stay in the city and never finish high school, entering the field of work, especially if we take into account that for young people living on the farm the entry into adulthood occurs much earlier. (OLIVEIRA, 2014).

In both fragments, the category of transience is strong and associable with youth, as if nature tends to a process of changes and adaptations. Thus, to deepen the discussion of a specific group (young people of the IRPAA republic) it is necessary to enter into the epistemological universe of some terms and categories, for a better understanding.

The fragment quoted above, Oliveira, deals with some of the characteristics of the young people who live or who have passed through the IRPAA republic, where the construction processes (identity, gender, professional) associated with the cultural diversity of the spaces in which young people are inserted IRPAA and CETEP), besides the comings and goings of their communities, in addition to the subjective and personal transformations, causes in a new reflection on itself, in which the author identifies as a process of hybridity.

These processes of insertion and influence of several patterns in which we denominate of hybridity, (comes from the Greek Hybris) refers to the mixture of things of different orders, resulting in the excess. The term "hybrid" is also associated with "mestizo" and "heterogeneous" (MADEIRA, 2010, p.2). Where the hybrid occurs as a "[...] process of diversification through mixing [...]" and not "... as a process of homogenization". (IDEM, 2010, p.4) "to name some objects, practices and processes of our contemporaneity, only the word hybrid seems to serve to give some reference to experience. The hybrid invades our daily lives." (IDEM, 2010, p.1).

As Durston says, the transition in the juvenile phase occurs in both rural and urban areas, this movement is more visible and strong when we deal with young people from the countryside who are often in contact for the first time with an urban culture / globalized. This movement between comings and goings (republic-school, republic-community) of the youth of the republic, contribute to the movement of hybridity, reconfiguring the individual, giving the opportunity to re-evaluate his role as subject in that community.

To think of the youth that inhabit the republics of the IRPAA is a transitional condition, which is directly related to the development of the individual (young), initially marked by its history, religion, culture and customs and has direct cultural and social influences from the context in which it is inserted. In addition, other influences are constant in the life of the IRPAA youth, they are experiencing a training phase, which in this case of two institutions, where the CETEP (technical course = formal) and the IRPAA internal, training, courses and mini-course = non-formal), which introduce multiple knowledge and ideologies in the residents, where they are processed, decoded and passed on or reproduced in their social circles.

The following is a sequence of narratives that characterizes the transitory movement that constitutes these young people,

[...] eu tinha uma visão sobre a sociedade, sobre tudo, com a minha vivência aqui no IRPAA, as formações, até mesmo alguns disciplinas no CETEP, eu pude mudar o meu ponto de vista,[...], a formação política como exemplo,[...]quando eu fui na folga a minha comunidade, já via com outros olhos a postura de meus amigos, que é muito machista, homofóbicos, e não é desse jeito, todos são iguais e tem o mesmo direito, ao voltar para república, pude ver o quanto mudei para melhor. (AZULÃO, DIÁRIO DO COTIDIANO, 2018)

[...] hoje eu surubim, estou contribuindo, com meus conhecimentos adquirido no IRPAA e CETEP, na cooperativa de Uaua, Curaça e Canudos COOPERCUC; na região de Curaça em um território quilombola, que é o quilombo de Valdemar, na Nova Jatobá, tem pouco tempo, mas já tenho projeto, para a comunidade e confesso diante de tudo que passei, dei um tapa na cara da sociedade, a quem não esperava por isso; to dando o melhor de mim, que não é pouco, rrsrsrs...to muito feliz a pesar que demorei muito para exercer a minha profissão mas tudo no tempo de Deus (SURUBIM, DIÁRIO DO COTIDIANO, 2018)

Based on the reports, we observe that from a different point of view, the experience and coexistence in these spaces, go to a transformation, which occurs every time

and round, evaluations and reevaluations and, finally, reflection.

With all the elements mentioned here, we believe that specifically related to these young people who are of different origins, whether from the field with traditional bases (indigenous, quilombolas, fishermen, family farmers, relatives, pasture fund, social movements, etc.), constitute as transient young people, which is the result of the process of construction of the subject, from the youthful hybridism, influenced by the transient movements.

Returning to the discussion, the transitional term, discussed by Oliveira (2014) in his master's thesis, is amplified and strengthened here. For a better understanding, the term is associated with something that is in constant movement, is in a transversal process, passing through other processes and movements. In this way, I see the young people of the IRPAA in a process, totally different from other young people who find themselves in the same dynamic, residing in republics, but these with subjectivities and interlaced in different ways.

III. CONCLUSION

The daily life revealed by these young people in narrating and reflecting on their youthful condition, a condition that corroborates with that presented by Dayrell (2003) in linking the debate to the dimension of transient as a possibility of "becoming", so also the young people are gradually becoming stronger and weaving learning that allows them to present themselves not only with a fixed age that determines whether they are young or not, it is beyond a category that is becoming distant from the ways of living and being in society, present themselves as constructors of their formative processes and in this way consider each element as meaningful for them to advance and assume the social roles and functions before their personal and professional performance.

As a result of these questions I return here the purpose of this writing. We propose to this end that the aim was to broaden the specificity of the historical approach that revolves around the discussion of "student republics" and "youth", especially when compared to the interdisciplinary approach, as well as to develop some theoretical / methodological considerations about a youthful condition experienced by these young people, in which we are considering "transient youth" from the experience since its origin in the countryside and the relationship established by studying and residing in the republic of the IRPAA.

What jumps in the reading of the narratives and the contact with these subjects is that the transience that constitutes these young people is delineated by subjective questions that are present in their identity marks and allow of this way to reflect the movement of coming and going, present in its trajectory in which they are led to leave their homes, the family's bosom, what is considered a "comfort zone", to live the different, the unpredictable, yet is not characterized as a permanent element, there is a presence of ephemerality that marks this transitory movement they live.

Beyond these aspects, it is pertinent to elucidate that in its narratives the place of transitory as a movement of construction and identity reconstruction is reinforced and is configured as a possibility of dialogue with its formative process. Dayrell, points out that,

On the other hand, we find ourselves in daily life with a series of images about youth that interfere with our way of understanding young people. One of the most ingrained is the youth seen in their condition of transience, in which the young is a "coming to be", having in the future, in the passage to adult life, the meaning of their actions in the present. From this perspective, there is a tendency to view youth in their negativity, which has not yet come to be (Salem, 1986), denying the present lived. This conception is very present in the school: in the name of the "coming to be" of the student, translated in the diploma and possible future projects, tends to deny the lived present of the young person as a valid space of formation, as well as the existential questions which they expose, far wider than just the future (2003, pp. 40-41).

Corroborating with the author's point of view, we come to the conclusion that youth can not be thought of, especially those present in rural territories or in the countryside, as the narrators of this research point out, as a mere temporal clipping or as a prognosis for the future. They come to live in the present time and their formative nuances as possibilities of self-affirmation and recognition are social subjects and the transitory here is only demarcated as the cut in the time in which they leave their zone of comfort and migrate to other spaces in search of growth and knowledge, in this case of vocational training, but which does not define the inherent aspects of its future or the denomination as subjects.

Young people come to recognize themselves as subjects and in this way are endowed with plans and plans for the future and, mediated by this transitory, temporary movement in which they demarcate their youthful condition, not as the reflection of a near future. Let us see what this young woman says,

[...] hoje eu penso diferente, quero terminar o curso técnico e fazer faculdade em zootecnia e dar um futuro diferente a minha comunidade,[...], aquela caracara que chegou aqui antes, não existe mais [...](CARCARÁ, DIÁRIO DO COTIDIANO, 2018)

In view of the above, we believe that with all the elements mentioned here, specifically related to these young people who are of different origins, whether from the field with traditional bases (indigenous, quilombolas, fishermen, family farmers, family, pasture fund, social movements, etc.), constitute as transitional young people, being the result of the process of construction of the subject, based on the youthful hybridity, influenced by the transient movements, what constitutes the main challenge to think about and propose formative processes that meet the specific needs of these subjects, whether in the educational field, social movements and / or human ecology, as we propose to articulate throughout the article.

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REFERENCES

- [1] BERNIERI, M. J (2002), Diversificação de Atividades no Espaço Rural: turismo, mais um componente para o desenvolvimento local? Vila Real: Dissertação de Mestrado, Universidade de Trás-os-Montes e Alto Douro/Universidade de Santiago de Compostela.
- [2] Brasil. (2013)Estatuto da Juventude (2013). Estatuto da juventude : atos internacionais e normas correlatas. – Brasília : Senado Federal, Coordenação de Edições Técnicas. 103 p.
- [3] CACCIA-BAVA, Augusto et. al. (2004) Jovens na América Latina. São Paulo: Escrituras.
- [4] CARNEIRO, M. J. T. (1998) O ideal rurano: campo e cidade no imaginário de jovens rurais. In Silva, F.C.T.; Santos, R.; Costa, L.F.C. Mundo Rural e Política. Ensaios interdisciplinares. Rio de Janeiro: Mauad.
- [5] CARVALHO, L. D. (2008) NATUREZA, TERRITÓRIO E DESENVOLVIMENTO RURAL NO SEMI-ÁRIDO BRASILEIRO: ESTUDO PRELIMINAR DAS AÇÕES DA ‘CONVIVÊNCIA COM O SEMI-ÁRIDO’ EM JUAZEIRO – BAHIA. Anais do 3º ENCONTRO DA REDE DE ESTUDOS RURAIS, UFCG, Campina Grande (PB).
- [6] CHAVES, E. O. C. Jr. (1999) Políticas de juventude: evolução histórica e definição. In N. Shor, M. S. F. T. Mota & V. C. Branco (Orgs.), Cadernos de juventude, saúde e desenvolvimento (pp. 41-48). Brasília: Ministério da Saúde, Secretaria de Políticas de Saúde.
- [7] CLÍMACO, A. A. S. (1991) Repensando as concepções de adolescência. Tese (Doutorado), Pontifícia Universidade Católica de São Paulo, São Paulo. 1991.
- [8] COSTA, S. G. (2010) A equidade na educação superior: uma análise das Políticas de Assistência Estudantil. Dissertação (Mestrado em Sociologia) — Universidade Federal do Rio Grande do Sul, Porto Alegre.
- [9] COSTA, T. P. (2017) A CONVIVÊNCIA COM O SEMIÁRIDO COMO PARADIGMA SUSTENTÁVEL NA PERSPECTIVA DO BEM VIVER. REVASF, Petrolina-PE, vol. 7, n.12, p. 79-100, abril.
- [10] DAYRELL, J. (2003) O jovem como sujeito social. Revista Brasileira de Educação. Set /Out /Nov /Dez. p. 40 - 52.
- [11] DICK, H. (2003) Gritos Silenciados, mas evidentes. Jovens construindo juventude na História. São Paulo: Edições Loyola.
- [12] FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. FAO Rural Youth Developmet. <http://www.fao.org/rural youth/faq.html>. Acessado em 30/06/2018.
- [13] GROppo, L. A. (2000) Juventude: ensaios sobre sociologia e história das juventudes modernas. Rio de Janeiro: DIFEL. Coleção Enfoques Sociologia.
- [14] IMPERATOR, T. K. (2017) A trajetória da assistência estudantil na educação superior brasileira. Serv. Soc. Soc., São Paulo, n. 129, p. 285-303, maio/ago.
- [15] LAFER, C. (1989) O Significado de República. Rev. Estudos Historicos, Rio de Janeiro, vol.2, n.4. p.215-224.
- [16] MACHADO, O. L. (2013a) As repúblicas estudantis. En Lemos, Paulo A História da Escola de Minas. Ouro Preto-MG (Brasil): Legraphar.
- [17] MACHADO, O. L. (2013b) Escola de Minas de Ouro Preto: Memórias dos seus ex-alunos. Frutal-MG: Editora Prospectiva.
- [18] MACHADO, O. L. (2013c) República Aquarius: a maior república estudantil das Américas. Frutal-MG: Editora Prospectiva.
- [19] MALTA, E. (2010) Identidade e práticas culturais juvenis: As Repúblicas estudantis de Ouro Preto. Dissertação (Mestrado em Ciências Sociais). UFS - Universidade Federal de Sergipe. São Cristóvão. 2010.
- [20] MARCHELLO-NIZIA, C. (1996) Cavalaria e cortesia. In: LEVI, Giovanni; SCHIMITT, Jean-Claude (Orgs). História dos Jovens 1: da antiguidade a era moderna. São Paulo: Companhia das Letras. P:141 - 190.
- [21] MENDÉS-FRANCE, P. (1963). A República Moderna (Trad. De C.M.M e Maria Manuel), Lisboa, Europa-America. P.229-252.
- [22] NIETZSCHE, F. W. A. (2001) Gaia ciência. Tradução, notas e posfácio de Paulo Cezar de Souza. São Paulo: Companhia das Letras.
- [23] NOVAES, R. R. (2000) “Juventude e participação social: apontamentos sobre a reinvenção da política”. In ABRAMO, H. W. et. all (org.) Juventude em debate. São Paulo: Cortez.
- [24] OLIVEIRA, A. D. (2014). Jovens no Semiárido Baiano: Experiências de Vida e Formação no Campo/ Adelson Dias de Oliveira. Salvador.

- [25] OLIVEIRA, L. M. S. R. (2005) EDUCAÇÃO RURAL E DESENVOLVIMENTO LOCAL SUSTENTÁVEL: A Lógica Subjacente das Relações Inter-Setoriais. BELÉM-PA.
- [26] Organização da Unidade Africana (OUA) – (1996) Análise Situacional da Juventude em África, Documento apresentado na Conferência Pan Africana sobre Juventude e Desenvolvimento Adis Abeba, Etiópia: Comissão Econômica para a África.
- [27] PAIS, J. M. (2003) Culturas juvenis. Lisboa: Imprensa Nacional-Casa da Moeda.
- [28] REIS, N. G. (2006) Notas sobre Urbanização Dispersa e Novas Forams de Tecido Urbano. São Paulo. Via das Artes.
- [29] REPOLÊS, M. F. S. (2007) A identidade do sujeito constitucional no Brasil: uma visita aos seus pressupostos histórico-teóricos na passagem do Império para a República, da perspectiva da forma de atuação do guardião máximo da Constituição.. In: XVI Encontro Preparatório do Conpedi, 2007, Campos dos Goytacazes - RJ. Anais Conpedi / Campos dos Goytacazes.
- [30] SCHNAPP, A. (1996) A imagem dos jovens na cida de grega. In: LEVI, Giovanni; SCHIMITT, Jean-Claude (Orgs). História dos Jovens 1: da antiguidade a era moderna. São Paulo: Companhia das Letras. P:19 - 57.
- [31] SILVA, V. (2004) Sertão de jovens: antropologia e educação. São Paulo: editora Cortez.
- [32] SOUSA, J. T. P. (1999) Reinvenções da utopia: a militância política de jovens dos anos 90. São Paulo: editora Hacker.
- [33] YOUTH AND YOUTH POLICY – A SWEDISH PERSPECTIVE. Suécia, (2010) https://www.mucf.se/sites/default/files/publikationer_uploads/youth-and-youth-policy.pdf. Acesso em 09/07/2018.

Cooperation and Competitiveness in Brazilian Crafted beer Production: The case of gypsy breweries in Goiás State

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Abstract— This paper aimed to present and discuss the craft beer production in Goiás state, Brazil, where brewers do not own the necessary equipment (gypsy breweries). Therefore, a literature review combined with qualitative interviews with gypsy brewers were carried out. The industrial and crafted forms of production have not been annulled, and forms of production have arisen that involved processes of sharing the infrastructures of large companies and crafted producers, as in the case of gypsy breweries, cuckoo or ghosts. The practices of gypsy breweries, therefore, left Europe and gained the world, and came to materialize in Goiás, Brazil. A country that stands out in the production and consumption of beer. Among the main positive aspects of the practice of gypsy brewing in Goiás, it was possible to perceive the stimulation of diversified consumption, the possibility of using equipment in a more efficient way, taking advantage of moments of vacancy, sharing knowledge, and stimulating improvement in the quality of production, and, among the main bottlenecks are the distribution structures of production, and, the existing taxes in Brazil.

Keywords— *crafted beer, gypsy breweries, cooperation, competition.*

I. INTRODUCTION

Patrick McGovern in his book “Uncorking the Past” points out that interest in accessing alcohol may have led men, hitherto, hunters and gatherers to plant cultivation and thus cease to be nomadic. In his research, the archaeologist was in different points of the world evaluating through biomolecular research traces of boilers, to verify the consumption and search for the extraction of alcohol under various forms in different cultures around the world.

The consumption of alcohol, therefore, has always been linked to human customs, and the advances of production and access to alcohol have been diverse throughout the history of humanity. These advances are linked both to the act of producing, to the distribution and forms of organization and management of production.

The study and mastery of fermentation and refrigeration techniques facilitated the production of alcoholic beverages on a large scale.

This article deals with the production of alcohol, specifically beer, and brings elements that support us to reflect on how the relations of production sometimes

point to a complex reality that advances and makes ponder over the conceptual issues. In this article, we focus on how beer production came about, gained scale, and reached the different points of the country and at the same time diversified. This means that the relationship between production and consumption is complex, it is not just about consuming a product, but also about diversifying consumption. And, this diversification requires diverse strategies.

It transpires that beer production and the competitiveness of a global market could both undermine crafted beer productions, their potency and supply capacity, but simultaneously generated a demand for an increasingly diverse production.

Thus, the large breweries began to serve several countries in the world, and as a parallel phenomenon, small and medium-sized breweries also exposed large companies and society itself, its importance and wealth. And for this to be possible it was necessary to develop operating strategies, since small and medium-sized productions do not always access structures for production.

The mode of production called Gypsy Breweries, Ghosts, or Cuckoo are therefore an object of analysis, especially the gypsy production, because it is a strategy of production on a smaller scale and, using equipment and infrastructure of larger breweries.

Thus, gypsy production allows a brewer, who has neither a factory nor the means of production, to access the means of production of another producer to create his product.

In this case study, the gypsy production in Goiás state, in central Brazil, will be analyzed. It is noteworthy that Brazil is a country of competitive international production and, theoretically, an environment with great supply and brewing culture.

Therefore, it should be noted that the existing consumer environment has also become demanding and has enabled the production of smaller breweries and of gypsy beers.

Gypsy breweries were thus called from the beer production proposals alternatively by the Danes Mikkel Borg Bjergsø and Kristian Klarup Keller. These are beers produced using the structure of industrial breweries, which allow, by means of a contract, stipulating payment methods for the use of equipment, which make it possible to produce beer from being handmade or homemade to becoming commercial or industrial.

In this sense, it is necessary to reflect on the different forms of production processes that occur within the traditional production system. One can see in what way consumption has transformed allowing the co-existence of products of large companies, and the diversified ones.

II. DYNAMICS OF BEER PRODUCTION AND CONSUMPTION WORLDWIDE

The consumer society is a reality in many developed and developing countries of the world. In developing countries, or unequal countries such as Brazil, this consumer society has advanced in recent years.

As the unequal countries advance in stimulating their consumer markets, the lower classes advance in the consumption of different products, hitherto not accessible or unknown in different parts of the world.

Regarding the beverage market, the advance in consumption is no different. The market for alcoholic beverages in Brazil and in the world has grown since its birth.

The beer market is diverse, with small, medium and large productions that have spread throughout the world.

A craft beer is produced by a craft brewer. According to the Brewers Association (2018), in America, a craft brewer can be classified as:

- Small: Annual production of 6 million barrels of beer or less (approximately 3 percent of U.S. annual sales). Beer production is attributed to a brewer according to the rules of alternating proprietorships.
- Independent: Less than 25% of the craft brewery is owned or controlled (or equivalent economic interest) by a beverage alcohol industry member which is not itself a craft brewer.
- Traditional: A brewer which has most of its total beverage alcohol volume in beers whose flavors derive from traditional or innovative brewing ingredients and their fermentation. Flavored Malt Beverages (FMBs) are not considered beers.

Before the advance of capitalism to Southern countries, production was concentrated in the Northern hemisphere. Thus, until the end of the decade of 1930, the countries that produced more beer were: United States, Germany and, Great Britain.

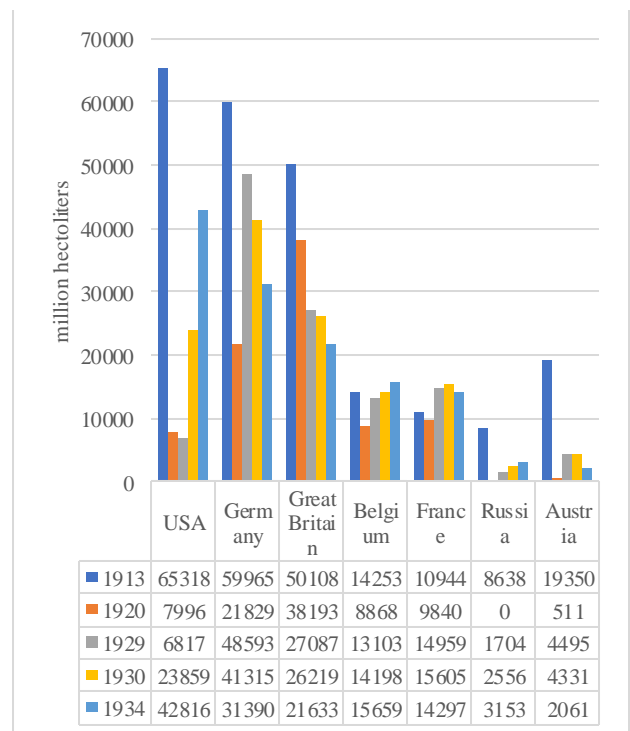


Fig.1: Main beer producing countries, 1913-1934 (selected years, in million hectoliters).

Source: Limberger (2016, p. 27)

By the 1960s, the scenario had not yet been modified. Therefore, the largest producers in the world were represented by the countries: United States, the Federal Republic of Germany (West Germany) and Great Britain.

There was loss of importance in the case of Belgium and growth in the case of Russia and Czechoslovakia.

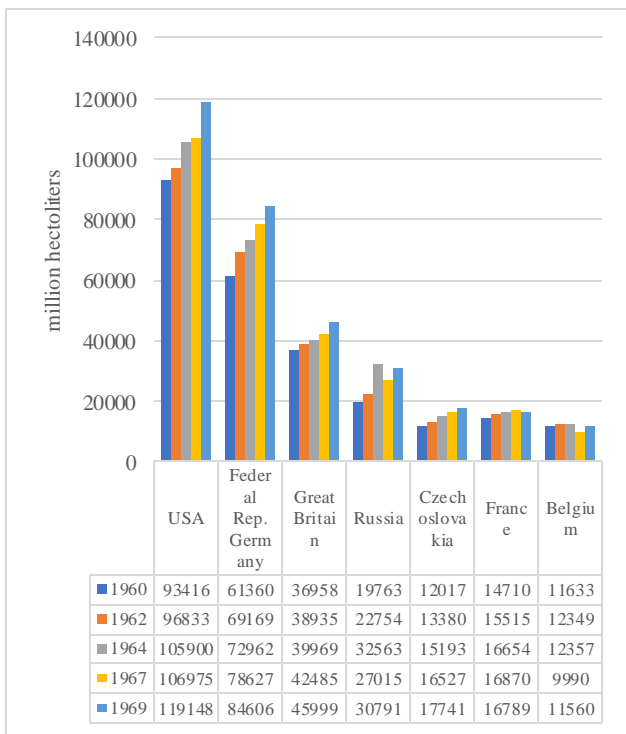


Fig.2: Main beer producing countries in the 1960s (selected years, in million hectoliters)

Source: Limberger (2016, p. 31)

After this configuration, along the expansion of brewing production in the world, countries traditionally producing beer were losing space, and, according to Limberger (2016), traditional brewing countries were losing ground to production growing in the periphery countries of the capitalist system, and the enterprises of these countries were expanding into these new emerging markets. The degree of concentration has increased, products have been globalized and competition has been faced more intensively in the world market (Limberger, 2016, p. 10).

These transformations have generated changes in global production scenarios.

Big countries in beverage production point to the sector's competitiveness worldwide. The largest breweries in the world are in countries in Europe and America, with data that draw attention to countries such as Germany, the Netherlands, the United States and, in recent years, Brazil.

Brazil stood out in the decade of 2010 by the growth of the industry and the acquisition of foreign industries, showing international competition. Producers such as Ambev and Inbev are examples of this expansion.

Table 1: Global Beer Production by Country in 2016

		2016					2015	
2016 Rank	2015 Rank	Country	Production Volume (kl)	Growth from Previous Year	Global Market Share Incremental (%)	Global Market Share Cumulative (%)	Production Volume (kl)	Growth from Previous Year
1	1	China	41,416,700	-3.7%	21.7%	21.7%	43,008,000	-4.3%
2	2	United States	22,135,300	-0.7%	11.6%	33.3%	22,286,900	-1.4%
3	3	Brazil	13,334,600	-3.8%	7.0%	40.3%	13,857,500	-2.0%
4	4	Mexico	10,500,000	8.1%	5.5%	45.8%	9,710,000	-4.5%
5	5	Germany	9,495,700	-0.7%	5.0%	50.7%	9,562,300	0.4%
6	6	Russia	7,810,000	-0.4%	4.1%	54.8%	7,841,400	2.3%
7	7	Japan*	5,352,000	-2.1%	2.8%	57.6%	5,464,300	-0.1%
8	8	United Kingdom	4,373,400	-0.9%	2.3%	59.9%	4,413,100	-0.5%
9	10	Vietnam	4,080,000	11.2%	2.1%	62.1%	3,670,000	20.1%
10	9	Poland	4,073,100	-0.4%	2.1%	64.2%	4,090,000	3.5%
11	11	Spain	3,620,000	4.1%	1.9%	66.1%	3,477,500	3.7%
12	12	South Africa	3,200,000	-0.4%	1.7%	67.8%	3,213,000	2.0%
13	13	Nigeria	2,600,000	-3.7%	1.4%	69.1%	2,700,000	0.0%
14	14	France	2,468,000	2.7%	1.3%	70.4%	2,402,000	17.3%
15	15	Netherlands	2,455,900	2.3%	1.3%	71.7%	2,401,200	1.3%
16	16	Thailand	2,403,600	2.0%	1.3%	73.0%	2,356,200	6.4%
17	17	India	2,210,000	4.2%	1.2%	74.1%	2,120,000	6.0%
18	19	Belgium	2,061,600	4.1%	1.1%	75.2%	1,981,100	8.8%
19	18	South Korea	2,000,000	-2.7%	1.0%	76.3%	2,056,300	-0.9%
20	22	Czech Republic	1,929,900	1.4%	1.0%	77.3%	1,903,300	2.4%
21	24	Colombia	1,910,000	5.5%	1.0%	78.3%	1,810,000	5.2%
22	23	Canada	1,900,000	0.1%	1.0%	79.3%	1,897,300	0.2%
23	25	Argentina	1,800,000	7.1%	0.9%	80.2%	1,680,000	1.8%
24	21	Ukraine	1,798,000	-7.6%	0.9%	81.1%	1,946,000	-19.6%
25	28	Philippines	1,650,000	5.8%	0.9%	82.0%	1,560,000	4.0%
		Global Total	190,918,700	-0.6%	100.0%	100.0%	191,991,300	-0.6%

Source: Kirin Beer University (2017)

The data that present the production by country therefore expose a geography of production by volume different from the geography of production by diversity. Thus, after the 1990s, there was a great transformation in the brewing production scenario. And in the decade of 2010, the countries that stood out in production, in volume, worldwide, were China, the United States and Brazil.

When the data are analyzed by region, Asia presents itself as the first producing region of the world, and the second region is represented by Europe, which with all countries, constitute a larger production than North America, and South America not summed.

Table 2: Global Beer Production by Region in 2016

Region	Production Volume in 2016 (kl)	633ml Bottle Equivalent (million bottles)	Growth from Previous Year	Global Market Share	Production Volume in 2015
Japan*	5,352,000	8,455	-2.1%	2.8%	5,464,300
Asia (excluding Japan)	57,802,100	91,315	-1.5%	30.3%	58,677,200
Asia Total	63,154,100	99,770	-1.5%	33.1%	64,141,500
Europe	52,097,100	82,302	0.5%	27.3%	51,830,800
North America (United States and Canada)	24,035,300	37,970	-0.6%	12.6%	24,184,200
Central and South America	34,039,300	53,775	-1.1%	17.8%	34,426,200
Africa	14,504,100	22,913	1.5%	7.6%	14,284,900
Middle East	1,059,200	1,673	-2.6%	0.6%	1,087,000
Oceania	2,029,600	3,206	-0.3%	1.1%	2,036,700
Global Total	190,918,700	301,609	-0.6%	100.0%	191,991,300

Source: Kirin Beer University (2017)

Historically, there have been major changes in beer consumption worldwide. In recent times, the per capita

consumption has decreased in traditional “beer drinking nations” while it increased strongly in emerging economies. Climatic conditions, religion, and relative prices also influence beer consumption (Colen & Swinnen, 2016).

A quantitative empirical analysis by Colen and Swinnen (2016) demonstrates that the relationship between income and beer consumption has an inverse U-shape. With rising incomes, beer consumption initially increases, but at higher levels of income it falls.

According to Stack et al. (2016, p.54), “Although beer is an ancient beverage, brewing as an industry was not historically one of the driving forces of globalization. Certainly, there are instances during the past century of specific brands being made available in other countries, but for the most part, beer brands have not crossed national borders. In many countries, beer, more than many products, has become intertwined with notions of national identity and pride. As a result, the efforts to internationalize in this market must overcome deep cultural associations regarding the product, the producer and the consumer.”

III. THE PREFERENCE FOR CRAFT BEER

The consumer worldwide is showing a growing preference for craft beer. Figures from Euromonitor International (2014) revealed annual market share gains at rates of 3%. In order to understand this shift in preference, it is fundamental to know about the brewing revolution that has been taking place on a global scale in recent years. It is an international movement with emphasis on regional and technological productive transformations. Although beer has been produced since 8000 BC, its global popularization happened after the Second World War (Oliveira & Barcelos, 2017).

From the 1950s up until the 1980s, the production and distribution of beer in countries such as the United States and the United Kingdom were planned to satisfy a uniform and growing demand; there was little room for diversification in the product. In this period, the brewing industry became highly concentrated with few high capacity global players offering a standardized and blended product worldwide (Cabras & Bamforth, 2016). This international scenario in the 1980s was the leitmotif (one of them) for the rise of micro-breweries with new possibilities of diversification translated for the consumers in terms of choice and taste.

The characteristics of the big players (generalist firms) in the beer market left peripheral space for the upsurge of small players, specialist firms (micro-breweries, brewpubs, contract brewers) that chose narrow

homogenous targets at a regional scale (Cabras & Bamforth, 2016). The increase in the number of small specialist firms came in response to the increasing dissatisfaction of consumers with bland products offered by major brewers. “These trends indicate that consumers’ tastes were becoming increasingly sophisticated and micro-brewers were better able to cater for this market” (Cabras & Higgins, 2016, p. 615).

The interest for stronger flavors was one important reason for the rise of craft beer but not the only one. Consumers were also looking over quality, accepting drinking less but drinking better (Euromonitor International, 2017). The driver for craft beer is as much linked to notions of localization, authenticity and heritage. In fact, this interest was sparked five decades ago with a pioneer initiative in the United Kingdom called Campaign for Real Ale (CAMRA), a movement of beer lovers that valued the traditional way of producing and storing beer. This was the first wave by Cabras and Bamforth (2016). The second wave happened in the early 1990s and was characterized by the entrance of new founders barely connected to breweries or brewing, such as retirees or beer-lovers looking for a career change. The third wave came in the early 2000s and was testified by a growing number of micro-breweries due to the development in brewing technologies reducing the price of equipment that became more compact and easier to install.

The brewing revolution also had its branches in Latin America, an important emerging market. According to Oliveira and Barcelos (2017) the Brazilian brewing sector experienced a market transformation as the craft beer was introduced. Superior quality drinks and new flavors were highly appreciated in contrast to light beer which is subject to massive production.

The devotion manifested by beer lovers is such that they are willing to travel to experience a good product with full-bodied characteristics. More enthusiastic beer lovers are favorably disposed to know the beers as much as to understand their production process. In this vein, brewers in Brazil adopt integrative marketing strategies, like guided visits to factories, tours in specialized beer fairs, partnerships with bars and gastronomic places (Oliveira & Barcelos, 2017).

In short, the craft beer industry came as an answer to the complaint of consumers unsatisfied with the homogenized, standardized and blended flavor products made by dominant international players. In response to the growing sophistication of the consumer in the last decades, new organizational forms of business (small specialized firms) started supplying this consumer with

differentiated and stronger flavor products, made preferably with traditional processes guaranteeing the high quality demanded.

IV. DYNAMICS OF BRAZILIAN BEER PRODUCTION AND ITS COMPETITIVENESS

Brewery production in Brazil originated, according to Limberger (2016), mainly due to the European immigration that came to Brazil in the mid-nineteenth century. Small industries were formed in the South and Southeast and were being extinguished with the industrialization and growth of big companies.

The history of this productive sector reflects, therefore, the history of the population's advances in the territory, of urbanization and Brazilian industrialization. Therefore, as the population entered the territory, the phenomenon of urbanization and industrialization spread, and the beer industry also spread.

Figure 3 points out some of the main moments of the Brazilian industrial production and its dissemination in the territory. The industrial production, as can be seen, starts in the south and southeast of Brazil, and advances to the other regions.

Thus, at the end of 1800 there were already three Brazilian breweries, founded in the states of Rio de Janeiro and São Paulo. And, from 1930, Brahma and Antarctica began to seek to distribute their production in new regions of the national territory and acquire small businesses. A national competition was started for the growth of production and distribution in Brazil.

In the 1970s, Brahma acquired companies from the states of Goiás, Ceará, Bahia and Amazonas, and Antarctica acquired companies from the states of São Paulo, Rio Grande do Sul, Amazonas, Bahia, Minas Gerais, Goiás, Espírito Santo, Piauí and Paraná.

In the 1980s, Brahma acquired companies from the state of São Paulo, Paraná, Rio Grande do Sul and Rio de Janeiro. And, Antarctica acquired companies from Rio Grande do Sul, Minas Gerais, Rio de Janeiro, Paraná, Piauí, Paraíba and Rio Grande do Norte.

Thus, in the 1970s, Antarctica already had companies in all regions of Brazil, and Brahma had not only acquired companies in the South, and in the 1980s, both companies already had production in all regions of the country.

During the twentieth century, the great national companies reached the full extent of the national territory, with Brahma becoming the fifth largest brewery in the world in the 1990s and Antarctica among the fifteen largest in the world.

The process of acquisition of small and medium-sized breweries by large breweries occurred in several countries

worldwide, not only in Brazil. The sector presents product heterogeneity, brand diversity and great competition to access consumers.

As an example of the dynamics of growth and acquisitions reference may be made to the Dutch company Heineken. This company was also founded in year 1800 and guaranteed its expansion with the acquisition of companies in countries of North America, Asia and Europe.

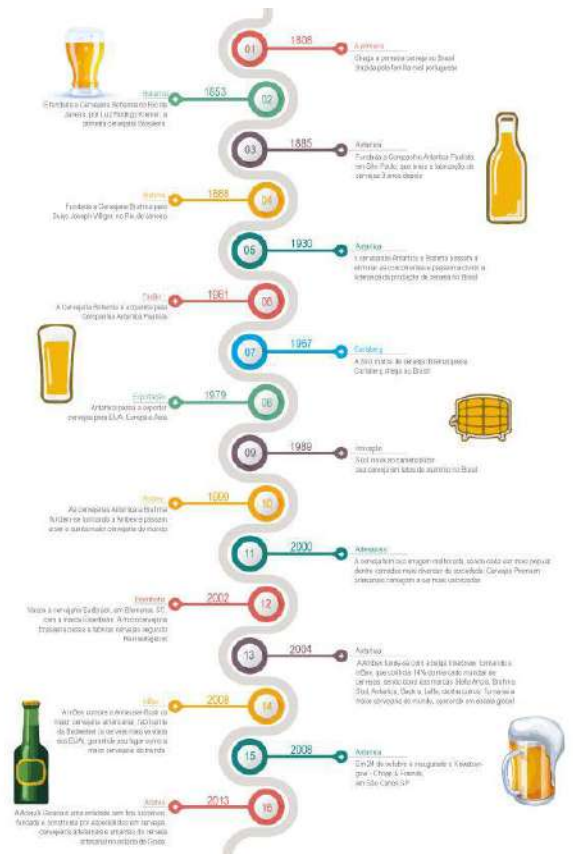


Fig.3: History of beer production in Brazil

Source: Janini (2009), <http://www.asterisko.com.br/asaga-da-erveja/>. Organization: Lopes, G.P.

The dynamics of competition between companies, however, became global and, throughout the 2000s, according to Limberger (2016), Brazilian companies were denationalized.

Thus, the market was controlled by groups such as AB-Inbev (and its subsidiary Ambev), which dominates almost 70% of the market, Kirin Brazil, (which acquired Schincariol), Heineken Brasil (which acquired Kaiser and Bavaria), and the Brazilian brewery Petrópolis. In this sense, four companies control 95% of the Brazilian market.

Nowadays the beer industry represents 1.6% of Brazilian GDP. 14,1 billion liters are produced annually. R\$ 21 billion in taxes go to the Government. 38 thousand of vehicles in fleet are used in distribution channels. 2.7 million jobs are involved. Each R\$ 1.00 invested in the beer industry, generates R\$ 2.50 in the Brazilian economy. 1.2 million outlets spread over the country. 99% of households are supplied with beer in Brazil. R\$ 107 billion of turnover in 2017 (Cervbrasil, 2018).

Brazil has approximately 117 thousand hectares planted with cereals destined to the production of beer. There are 610 breweries registered in the year 2017, just before the economic crisis in Brazil, 91 new breweries. There are 3 big companies dominating the market in Brazil; Ambev, Heineken and the Petropolis Group, the three together hold 98.6% of the world beer market (Martins et al., 2017).

Caravaglia and Swinnen (2018) documented when the craft beer movements started in various countries, and how they have evolved. The authors also discuss the role of changes in demand, the role of pioneers in craft brewing, and what factors determined the re-emergence of small brewers. Some of the factors discussed by the authors refer to the role of information, networks, regulation, capital, and technology markets.

V. THE COMEBACK OF SMALL AND MEDIUM SIZE BREWERIES AND THE DIVERSIFICATION OF PRODUCTION

Limberger (2016) identified the geo-economic dynamics of the Brazilian brewing sector, the presence of oligopolies and the emergence of smaller companies that the author called marginal. Marginal companies were considered micro-breweries to produce high value-added beers because they made profits that did not exceed the average profit.

From the 1990s onwards, Brazil presented a highly competitive environment with oligopoly leadership, and from the 2000s onwards, an environment of great potential for consumption of higher quality products was created, the income of the Brazilian population raised, and the lack of diversification of Brazilian beer production, which marketed several brands of distinct qualities, but of similar standards, has been overcome.

According to the Brazilian Institute of Applied Economic Research, between 2001 and 2011, the per capita income of the richest 10% increased to 16.6% in accumulated terms, while the income of the poorest grew notably by 91.2% in the period (IPEA, 2012).

The growth in the consumption of the products of marginal companies, which we call small and medium-

sized enterprises, was also due to the increase in the population's income, which consisted of beers of different standards and higher prices.

Thus, from the 1990s, after a long period of growth of the national brands Brahma and Antarctica, with the acquisition of several smaller breweries, small breweries of artisanal production began to be reborn. These producers had a differentiated strategy, since they were not producing, filtering, pasteurizing and bottling for trade, but producing for sale in barrels, bars or in the factory itself (Limberger, 2016). This phenomenon of craft beer production and appreciation of this production occurred in the 1970s in countries such as the United States and the United Kingdom.

The revival of small breweries comes therefore from artisanal productions, and from socioeconomic change, from enlargement of income, from cultural change and consumption, with the expansion of the demand conditions that allowed stimuli to appreciate differentiated products.

In a very significant group of microbreweries, the initial capital invested in the creation of the company comes from other industrial businesses, being the brewing activity a way to diversify the family business. In this group, we can mention the breweries Bierland, MisturaClássica, Colorado, Burgerman, DaDo Bier and Insana (Limberger, 2016, p.125).

In her analysis of Brazilian breweries, Limberger (2016) identified the following types: craft breweries, independent breweries, commercial microbrewery of the large company, and small traditional breweries.

- Craft breweries: small-scale enterprises, which produce in small quantities, with a small contingent of labor, for limited public, are concentrated in local or regional markets, do not invest in machinery, whose entrepreneurs dominate the productive process, including purchases and sales, whose investments are oriented to the creation of new products, and, optimization of the productive process with adaptations that do not require a large capital contribution.
- Independent breweries: they are companies concerned with increasing production, dynamics in conducting market research, product differentiation and the use of technology used in production. It is a competitor of both artisanal producers and leading companies.
- Commercial microbrewery of large companies: large companies, or leading companies have brands generated by acquiring independent

breweries, most of which operate to compete with independent breweries, are therefore breweries that produce different types of breweries. Beers from leading companies, which in general produce lagers and pilsner (or pilsener) but are controlled by the leading companies. Brazilian examples: micro-breweries Baden-Baden and Eisenbahn, acquired by Kirin, and Wals and Colorado acquired by Ambev-AB Inbev.

- Traditional small breweries: these are breweries dedicated to the production of traditional beers, of low price, and compete with beer brands in the local, regional, national and even international market. In the case of the national analysis, the Industria Nacional de Bebidas (INAB), Zani from Paraná, and Malta and Conti from the interior of São Paulo were taken as examples.

In Brazil, state governments defined craft beer and craft brewers in their legislation. The main aspects are related to limit quantity and marketing strategies (Beni, 2017, pp. 68-70).

The Brazilian craft brewers are organized in the Associação Brasileira de Cerveja Artesanal (Abracerva, 2018). According to Beni (2017, p.71), craft beers are those brewed by one of these three types of breweries in Brazil:

- Brazilian microbrewery: based in Brazil, with at least 50% of Brazilian capital, producing own brands or for third parties, with a total production of no more than 1 million liters annually;
- Gypsy microbrewery: based in Brazil, with at least 50% of Brazilian capital, with own brands and production rights, without own brewing equipment, producing at third party industrial plants, with a total production of no more than 1 million liters annually;
- Brewpub: based in Brazil, with at least 50% of Brazilian capital, producing and marketing at the same place. Marketing is restricted to the brewpub.

The scenario of new breweries completely changed the access to the products and diversified the consumption of the products in the country. They started to live and produce artisan, independent, commercial breweries, small traditional breweries, bars producers, as well as gypsy productions. This diversity allowed the expansion of the consumption of other styles of the drink, which stopped being a sector-only producer of pilsner (or pilsener) and lagers and began to produce diverse other types such as ales, pale ales, witbiers, saurs and others.

In year 2010, the culture of the consumption of more diverse products spread, and the productive sector entered the different states of the country with other forms of production, and other products.

According to the Ministry of Agriculture, Livestock and Food Supply (MAPA) in Brazil, in 2017, 679 establishments were registered as breweries, and presented 8903 registered products of breweries, beers and draft beer. Figure 4 shows the growth of Brazilian breweries 2002-2017.

Gráfico 1: Total de cervejarias por ano no Brasil

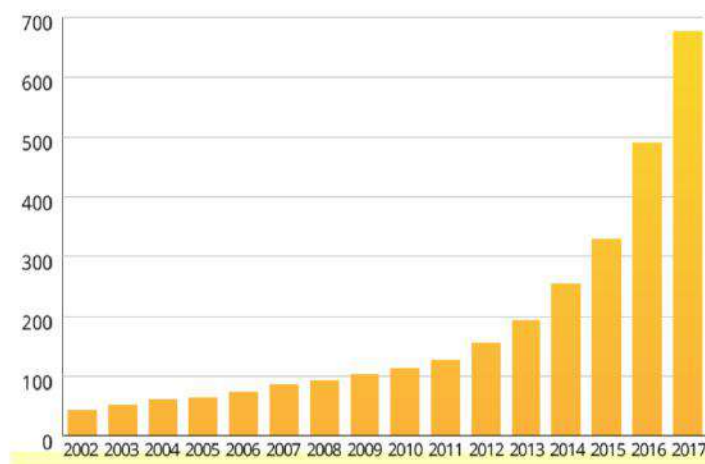


Fig.4: Number of breweries in Brazil, 2002-2017

Source: Ministério da Agricultura, Pecuária e

Abastecimento (MAPA). Available at: <http://www.agricultura.gov.br/assuntos/inspecao/produtos-vegetal/a-cerveja-no-brasil>. Accessed on Sep 2018.

Regarding the geographical distribution of breweries in Brazil, these are concentrated in the South and Southeast regions.

Table 3: Number of breweries in Brazilian states

State	Number of breweries
Rio Grande do Sul	142
São Paulo	124
Minas Gerais	87
Santa Catarina	78
Paraná	67
Rio de Janeiro	57
Goias	21
Pernambuco	17
Espirito Santo	11
Mato Grosso	11

Source: Ministério da Agricultura, Pecuária e Abastecimento (MAPA). Available at: <http://www.agricultura.gov.br/assuntos/inspecao/produtos-vegetal/a-cerveja-no-brasil>. Accessed on: September 2018.

The state of Rio Grande do Sul has the largest number of breweries, followed by the states of São Paulo and Minas Gerais, and Goiás is in the seventh position, according to the Ministry of Agriculture, Livestock and Food Supply (MAPA).

Thus, according to Carvalho et al. (2018), there is a growing market segment with different buying habits and behaviors compared to traditional beer consumers.

Craft beer emerged in Brazil during the 1990s (Krohn, 2018). With the high market concentration of bulk beer production, more and more consumers look for identity products, including beer. This creates new opportunities of interpreting competition and emerging markets.

VI. COOPETITION – COMPETING AND COOPERATING SIMULTANEOUSLY

The idea of coopetition, i.e. the simultaneous coexistence of competition and collaboration, is not new. Taking the chambers of commerce as reference, it is not difficult to understand that these institutions play an important role in the collaboration among competitors to address and solve common problems faced by the industry, such as the standardization of payment systems, lobbying on regulations, etc. One of the first chambers of commerce was found in Marseille, France, in 1599 (CCI, 2018).

The term “co-opetition” was first heard in the business context from the founder of Novell, CEO Ray Noords, in the 1980s: he argued that a company had to be able to compete and cooperate at the same time (Monticelli, 2015). In the academy the issue was introduced by Bradenburger and Nalebuff (1996); with the use of the theory of games as a support, the authors developed the dynamics of this paradoxical approach. Through collaboration, competitors can achieve better performance levels and above average profitability (Czakoń & Rogalski, 2014). As a research field, the issue is in its infancy with a limited body of literature (Ritala et al., 2016).

The firms cooperate to create value but compete for the results (Monticelli, 2015). In the coopetition relationship, agents cooperate in some activities and compete in others aiming at maximizing their gains. These relationships are based on confidence, reciprocity and altruism.

The advantages of the adoption of coopetition abound. With the game theory as reference, coopetition is a positive-sum-game (Bradenburger & Nalebuff, 1996), i.e., it is a kind of game where all the players involved can gain simultaneously. The arguments in favor of coopetition are plenty and can be listed as follows: gaining experience (Cygler & Debkowska, 2015); acquiring knowledge (Salvetat et al., 2013; Monticelli, 2015; Cygler & Debkowska, 2015); developing good business relationships (Cygler & Debkowska, 2015); increasing the size of the market, creating a new market, getting market power, augmenting the efficiency of resource utilization (Czakoń & Rogalski, 2014); accessing international opportunities (Granata et al., 2018); improving innovation capacity (Granata et al., 2018); maintaining competitiveness (Monticelli, 2015); attaining access to resources (Cygler & Debkowska, 2015; Granata et al., 2018; Hamouti, 2016; Maier, 2016; Monticelli, 2015).

There is a special interest in this paper for the access to resources and knowledge coopetition provides. A deal to concurrently collaborate and compete can be a gateway to the acquisition of complementary/supplementary resources. This way a firm can overcome technical, managerial, or infrastructural limitations. In their research, Cygler and Debkowska (2015) outlined that firms should try partnerships with competitors with a strong technological position. The authors argued there is a need for differentiation among the partners' abilities in order to permit an exchange of knowledge and capacity among them. The complementarity of resources is very important in the sense that one partner becomes able to access the other's necessary resources. This sharing facilitates the reduction of operational costs and improves the innovation capacity (Hamouti, 2016). Reporting a research in Southern Brazil, Monticelli (2015) highlighted that a great portion of the small wine producing companies could only have access to international fairs, for instance, because they were cooperating with each other in an integrative project supported by the Wine Brazilian Institute (IBRAVIN) and the Agency for Promotion of Exportation and Investments (APEX). Another example is given by Kempainen (2015) in the European payment system context, where partners compete in the provision of payment instruments and services for end-users but cooperate in building the payment infrastructure and defining relevant standards.

Although the advantages are well attested by the literature, coopetition does not happen without problems. As firms are friends and rivals at the same time, there are conflicts of logic in the cooperation/competition approach

(Ritala et al., 2016). This coexistence might produce a certain tension among the personnel involved; it is a kind of emotional ambivalence (Granata et al., 2018; Kempainen, 2015). To overcome the inherent stress cooperation might bring, employees and managers should be trained to deal and accept the contradictory situation.

VII THE GYPSY BREWERIES AS A COOPERATION STRATEGY

Sorj (2008) studied how capitalism in peripheral areas restores its socioeconomic premises and presents the non-capitalist characteristics of production, which present themselves as complementary and contradictory.

In this study, the productive structure of the coffee export chain in El Salvador was evaluated, as well as the established functional relations, where the non-capitalist appropriations are perceived at the base of the productive system, which, when traversing agents and social structures, reach export activity. They present themselves then, more deeply embedded in capitalist relations.

The author draws attention to the fact that, although more specifically in the case of El Salvador, this type of relationship can be investigated in other Latin American countries.

In the case of beer production, we can see variations in the structure of capitalism, especially considering the uses of small and medium-sized machinery.

It happens that periods of equipment vacancy do not add productivity, and therefore, the relations established between small and medium producers of traditional beers, can be changed to attend artisan producers, pointing to a different use of means of production, with actions of cooperation and sharing of the means of production that at first could be different strategies in the capitalist system.

At first, sharing the means of production with other producers could mean loss of strength and diminishing the competitiveness of that producer holding the means of production. But in a highly competitive environment, it can be a strategy of access to new knowledge through the accompaniment of the artisanal production mode, made available by sharing its space and machinery.

And, in a complementary way, the artisan producer is interested in accessing equipment that does not have capital and structure, and thus enables production, and reaches a greater scale of production even with the sharing of some information through the strategy of collaboration, cooperation and sharing. There is exchange of knowledge for access to idle equipment.

Brewing beer without having a factory for it means producing in a Gypsy, Cuckoo, or Phantom way.

In the Brazilian Midwest, the brewing sector is characterized as one of the most relevant and versatile sectors of the Brazilian economy in relation to the growth and creation of new commercial niches (Lima et al., 2017).

A study by Thomé et al. (2016) suggests that the only significant item to the consumers' luxury value perception in the dimension of financial value is the higher price of premium beers.

According to Lima et al. (2017, 655-656), among the states of the Brazilian Midwest region, Goiás state has more brewers than Mato Grosso, Mato Grosso do Sul and Distrito Federal together.

Thus, although it has been exposed that in Brazil, Rio Grande do Sul stands out, it can also be said that regionally, that is, in the Midwest, Goiás stands out in the production of artisan beers and in gypsy production.

In Goiás, it is possible to identify breweries in the different categories presented above. But in general, the small traditional breweries will be presented to introduce the profile of these breweries in Goiás and present the strategy of the Gypsy Brewery and its partnerships with this type of brewery.

Goiás state is in Central Brazil. The federal capital Brasília is located within Goiás state. Goiás state has beer production structures serving national as well as local production.

According to the Integrated System of Agricultural Products and Establishments - SIPEAGRO of the Ministry of Agriculture, Livestock and Supply, there are 29 registered breweries in the Midwest, of which 18 are concentrated in Goiás.

Of the 18 breweries registered at MAPA, 02 are large breweries, Ambev and Brasil Kirin, and the others are small and traditional breweries, responsible to produce pilsner (or pilsener) and lager beers, and there are also breweries that produce different types of beers, such as Santa Dica.

Table 4: Breweries of the Brazilian Midwest registered at the Ministry of Agriculture, Livestock and Food Supply (MAPA).

CENTRO OESTE			
ESTADO	RAZÃO SOCIAL	ATIVIDADE	DENOMINAÇÃO
DF	JINBEER CERVEJARIA ARTESANAL ME	PRODUTOR	CERVEJA
DF	MAFIABEER INDUSTRIA E COMERCIO DE BEBIDAS LTDA ME	PRODUTOR	CERVEJA
GOIÁS			
ESTADO	RAZÃO SOCIAL	ATIVIDADE	DENOMINAÇÃO
GO	AMBEV S.A.	PRODUTOR	CERVEJA
GO	BRASIL KIRIN INDUSTRIA DE BEBIDAS LTDA	PRODUTOR	CERVEJA
GO	CERVEJARIA GOIAZ LTDA - ME	PRODUTOR	CERVEJA
GO	CERVEJARIA SHERIFF LTDA - ME	PRODUTOR	CERVEJA
GO	CERVEJARIA TEMPLÁRIA LTDA ME	PRODUTOR	CERVEJA
GO	EMPRESA NACIONAL DE CERVEJAS E BEBIDAS S/A	PRODUTOR	CERVEJA
GO	KLARO - MICROCERVEJARIA LTDA - EPP	PRODUTOR	CERVEJA
GO	KLIMA INDUSTRIA E COMERCIO DE BEBIDAS LTDA	PRODUTOR	CERVEJA
GO	LUZ HUMBERTO GONÇALVES GOMES EIRELI-ME	PRODUTOR	CERVEJA
GO	MICRO CERVEJARIA LHAS EIRELI ME	PRODUTOR	CERVEJA
GO	MICROCERVEJARIA CATALÃO LTDA	PRODUTOR	CERVEJA
GO	MILTON JOCHIMS & CIA.LTDA - ME	PRODUTOR	CERVEJA
GO	NATTOS BEER MICRO CERVEJARIA LTDA - ME	PRODUTOR	CERVEJA
GO	REAL MICRO CERVEJARIA LTDA - EPP	PRODUTOR	CERVEJA
GO	SABA INDUSTRIA ALIMENTICIA LTDA-ME	PRODUTOR	CERVEJA
GO	SANTA DICA BEBIDAS LTDA ME	PRODUTOR	CERVEJA
GO	SANTA LUZIA INDUSTRIA E COMÉRCIO DE BEBIDAS LTDA	PRODUTOR	CERVEJA
GO	SERRA AZUL INDUSTRIA E COMERCIO DE BEBIDAS LTDA - ME	PRODUTOR	CERVEJA
MATO GROSSO DO SUL			
ESTADO	RAZÃO SOCIAL	ATIVIDADE	DENOMINAÇÃO
MS	CERVEJARIA MOBIER LTDA	PRODUTOR	CERVEJA
MS	CERVEJARIA PANTANAL LTDA ME	PRODUTOR	CERVEJA
MATO GROSSO			
ESTADO	RAZÃO SOCIAL	ATIVIDADE	DENOMINAÇÃO
MT	AMBEV S.A.	PRODUTOR	CERVEJA
MT	BIONDA INDUSTRIA DE BEBIDAS LTDA ME	PRODUTOR	CERVEJA
MT	CERVEJARIA LOUVADA LTDA - ME	PRODUTOR	CERVEJA
MT	CERVEJARIA PETROPOLIS DO CENTRO OESTE LTDA.	PRODUTOR	CERVEJA
MT	DARK SIDE INDUSTRIA E COMERCIO DE BEBIDAS EIRELI	PRODUTOR	CERVEJA
MT	MICRO CERVEJARIA SERRANA LTDA	PRODUTOR	CERVEJA
MT	RODRIGO EDUARDO GUNHA ME	PRODUTOR	CERVEJA

Source: Lima (2017). Available at: <https://portalseer.ufba.br/index.php/nit/article/view/23041/23041>. Access on: September 2018.

Beer production in Goiás therefore represents part of the national scenario, with the production of traditional beers by large industries, and names, global competitors, such as Ambev and Brazil Kirin, with local industries of conventional products and with local industries of diversified products. In this way, the regional and local scenario presents itself as diverse and heterogeneous.

According to the local legislation (Goiás State Law no. 13,194/2016), a craft brewer produces a maximal amount of 5 million liters of beer annually.

In addition to the productions cited, there are Gypsy productions.

So, in Goiás, as in other parts of Brazil, there is an activity called Cervejaria Cigana (gypsy brewery). It is a collaborative activity between bottled and drafted beer producers and craft beer producers.

This action seeks to enable craft brewers to access the structures of small or medium industries to produce on a larger scale. But, at the same time, the small and medium-sized industrial companies come to know the recipes and methodologies of production of the craft brewers. For this

reason, it is a strategy of shared use of structures that benefits both craft producers and industrial producers.

There are some Gypsy Breweries in Goiás. According to interviews with artisan producers and gypsies associated with the Goiás Brewery Association, there are at least 06 Gypsy breweries in Goiás, and at least another sixteen Gypsy breweries in the Federal District that also operate in Goiás. Below the main breweries gypsies who work in Goiás:

Table 5: Gypsy breweries active in Goiás state and their state of origin

	Brewery	Label	Beer types	Municipality of origin
1	Bispo		American Pale Ale (APA) and Blond Ale	Brasília-DF
2	Corina		Double India Pale Ale (IPA), Pale Ale	Brasília-DF
3	Lola		Witbier, IPA	Goiânia-GO
4	Metanoia		Witbier	Brasília – DF
5	MJ		IPA e Pale Ale	Anápolis-GO

6	Pigmeu			
7	Russian Bear			Goiânia-GO
8	Santa Dica		IPA, Hibisco and Kolsh	Pirenópolis-GO
9	Seresta		Lager, Weis and IPA	Goiânia-GO
10	Tortuga			Taguatinga-DF
11	Vila Boa		IPA	Cidade de Goiás-GO

Source: Research results

For the present research, questionnaires were sent to all 11 artisan producers and gypsies in Goiás state to answer the questions related to the forms of production, the impact of this type of activity in stimulating the consumption of differentiated products and the main challenges of this type of production. From the 11 existing gypsy breweries, four have responded our

questionnaire. The main characteristics were shown in Table 6.

Table 6: Main responses of the representatives of gypsy breweries in Goiás state

Question	Gypsy brewery			
	LOLA	MJ	Vila Boa	Corina
Location (municipality in Goiás state)	Goiânia	Anápolis	Cidade de Goiás	
What do you consider a gypsy brewery?	The term summarizes the operation of a brewery by contract, where the industrial plant is contracted, and the contractor is the gypsy.	Brewery that does not have its own factory.	To the one that does not have own structure of factory and establishes a negotiation with another brewery that has this structure of form to produce its own beer (recipe) in this place.	Brand of beers that outsources factory operation to the industrialization of its labels.
How are contracts and forms of action signed? (Factor conditions)	There are two ways: via processing of raw material where the gypsy buys and passes to the brewery the inputs or purchase of finished product	Usually it is a standard contract.	I know only what Vila Boa Brewery signs: A production contract, which establishes values, quantity, conditions and forms of payment. That clarifies about the ownership of the recipe in question.	I know three forms of contract: Shipment of industrialization, Royalties, and Distribution.

	n of the establishment. There are different taxations and different legal figures in each mode of operation .			
How can the production and consumption of gypsy beers access regional or national markets? (Influence on Factor and Demand Conditions)	Firstly, there is a change in the taxation of gypsies (ICMS-ST double taxation in interstate operations, a statute that stands at the supreme court STF) and the emergence of new factories (more capacity)	Generally, they are microbreweries that will sell only to your region.	Through the appreciation of #drinklocal culture, the use of typical ingredients, the joining of beer with local cultural aspects and advertising and targeted advertising.	Through collaborative labels and cross-brand partnerships; structuring of a supply chain specific to the segment, through incentives to the crafted beer production with the due reduction of taxes, especially ICMS.
How can gypsy	By giving more	Facilitates the life	Gypsy production can increase the	With more innovat

production influence local consumption? (Influence on Demand Conditions)	options to the final consumer there is a worsening and warming of the market, encouraging the consumption of fresh produce and the appearance of new products. If it were not the gypsies today, we would only have four local handmade brands.	of those who do not have capital to set up a factory .	market by bringing more breweries to the medium. As the investment in the factory is very high, we would not be able to diversify into brewery, styles and labels the way we are doing.	ive products since as the cost is higher, it is necessary to add value to the product . At the same time, there is more time for research and development.
What are the gypsy breweries in Goiás ? (Related and supporting industries)	It is difficult to have an exact number because it is a market with many new companies. Some that I know of GO: Lola, Seresta, MJ, Vila Boa, Pigmeus,	MJ, Lola, Seresta, Russia n, Vila Boa.	Vila Boa Cervejaria, Seresta, Lola, MJ, Cerrado, Corina, Metanoia, RussianBeer.	Corina cerrado beer, Carolina, Metanoia, Nomoco, Umabeer, Lola, Activista, EntreQuadradas, Bracitorium

	Santa Dica. From the DF: Corina, NoMoCo, Metanoia, EntreQuardras, Tortuga, Bispo. Abracerva must have some data.			
In which companies or structures do these gypsy breweries operate? (Related and supporting industry)	Basically : KlaroMicrobrewery, Cavalo Louco, Colombina andTemp lária Cervejaria (Catalão) . But there is practically a monopoly of Klaro, since it was the one that invested the most in volume and infrastructure.	Klaro	BreweryKlaro, BreweryGoyaz (Colombina), Brewery Cavalo Louco	Klaro, Stadt, Cavalo Louco
What kind of	Crafted and independ	Crafted and indepe	Craftedandindependentbreweries.	Crafted and indepen

brewery does your gypsy brewery support? (Related and supporting industry)	endent breweries .	ndent breweries.		endent breweries.
Is there support for the logistics of distribution of gypsy beers? (Related and supporting industry)	Yes. There are autonomous professionals who provide this type of service, as well as some breweries .		No	No
What are the advantages and disadvantages of this way of acting ? (Strategies, structure	Advantages: low risk and ease of operation . Disadvantages: limiting the idle capacity of the brewery and loss of competitiveness (the final	There is usually a standard contract.	Advantages: less investment Disadvantages: higher cost, accounting insecurity, low control over the logistics of the production process and difficulty in production planning due to this, subject to constant cost change.	Disadvantage in product cost and distance of quality control. Advantage is in value of investment, lean

and rivalry)	value of the product is higher through the nature of the operation).			operation and time to invest in the brand.
What are the main challenges of artisanal and gypsy production? (Strategies, structure and rivalry)	The challenge is the change of consumer habit, because there is not much appreciation of what comes from the outside yet. On the other hand, you need to invest in technology both on the shop floor and in marketing. This applies to the entire consumer chain.	Sale and distribution.	Win the uneven dispute with the large, the high tax burden, the difficulty in accessing credit lines, and the lack of union of the segment. For gypsies, the challenge is to act together to strengthen and defend exclusive interests.	Quality of equipment, team mentality, production costs and distance from large consumer centers.
Is there cooperation between gypsy	Yes. There is an exchange of information about	No.	Yes. Although the disunity still prevails, there are cooperation in events through invitations to	Yes. Events and labels together.

brewers in Brazil? (Strategies, structure and rivalry)	the operation, processes and contacts of suppliers.		participation.	
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Source: Research results

The answers present the functioning of gypsy production, its potentialities, bottlenecks and challenges. The main elements of this survey are: the importance of supporting the diversification of production, appreciation of culture, knowledge and local and regional ingredients, the use of idle equipment and infrastructures, sharing of knowledge and possibilities for innovation in processes, contractual relations, and products, and as main bottlenecks the lack of support and strategies for distribution of products, to achieve a larger scale of production of these products, fiscal incentives and lower taxation, as criticized by the producers, are the main bottlenecks.

Regarding taxes, Zobarán (2016) argued that the inclusion of Simples Nacional, adopted in October 2016, provided support for microbreweries, but this change did not appear in the producers' arguments. It is worth noting a local movement to encourage crafted beer production, through Law 3053-17, which establishes the Policy to Encourage the Production of Crafted and Drafted Beers in the state of Goiás. This law defines the microbrewery, and the incentives and requirements to achieve benefits such as reducing the rate of 10% for the product in its first and second year of validity, and from the third year this will be set at 17% in the state.

Thus, we can see a dynamic sector with unlimited capacity for innovation with respect to products, with oligopolies and market share with other types, and sizes of production and industries, with constant innovations in products, processes, and management and, with ranges ranging from international to local.

VIII. CONCLUDING REMARKS

The present article was about the consumption of beer as a custom that came from ancient times, which allowed the dissemination of the product in different parts of the globe, made possible the creation of large industries, oligopoly, reached different countries and localities and,

at the same time shares the market space with global and local products.

The industrial and crafted forms of production have not been annulled, and forms of production have arisen that involved processes of sharing the infrastructures of large companies and crafted producers, as in the case of gypsy breweries, cuckoo or ghosts.

The practices of gypsy breweries, therefore, left Europe and gained the world, and came to materialize in Goiás, Brazil. A country that stands out in the production and consumption of beer.

Among the main positive aspects of the practice of gypsy brewing in Goiás, it was possible to perceive the stimulation of diversified consumption, the possibility of using equipment in a more efficient way, taking advantage of moments of vacancy, sharing knowledge, and stimulating improvement in the quality of production, and, among the main bottlenecks are the distribution structures of production, and, the existing taxes in Brazil.

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REFERENCES

- [1] Uncorking the past. <https://m.folha.uol.com.br/ciencia/2009/11/653651-arqueologo-recria-roteiro-das-bebidas-alcoolicas-desde-antiguidade.shtml>
- [2] Brewers Association. (2018). Institutional website. Available online at: <https://www.brewersassociation.org>. Accessed: 01 sep. 2018.
- [3] Limberger, S. C. (2016). Estudo Geoeconômico do Setor Cervejeiro no Brasil: Estruturas Oligopólicas e Empresas Marginais. (PhD Dissertation, Universidade Federal de Santa Catarina). Available online at: <https://Repositorio.Ufsc.Br/Bitstream/Handle/123456789/174684/345360.Pdf?Sequence=1&Isallowed=Y>. Accessed: 29 aug. 2018.
- [4] Kirin Beer University (2017). Kirin Beer University Report Global Beer Production by Country in 2016. Available online at: https://www.kirinholdings.co.jp/english/news/2017/0810_01.html. Accessed: 01 Sep. 2018.
- [5] Colen, L., & Swinnen, J. (2016). Economic growth, globalisation and beer consumption. *Journal of Agricultural Economics*, 67(1), 186-207.
- [6] Stack, M., Gartland, M., & Keane, T. (2016). Path dependency, behavioral lock-in and the international market for beer. In *Brewing, beer and pubs* (pp. 54-73). Palgrave Macmillan, London.
- [7] Euromonitor International. (2014). Passport. Access on Sept 22nd, 2018. Available online at <http://www.euromonitor.com/passport#/home>.
- [8] Oliveira, G.R., and Barcellos, M.D. (2017). Technology, production paradigm and operation: transformation of the Brazilian brewing sector. *Journal of Operations and Supply Chain Management*, 10(2), 44-55.
- [9] Cabras, I., and Bamforth, C. (2016). From reviving tradition to fostering innovation and changing marketing: the evolution of micro-brewing in the UK and US, 1980-2012. *Business History*, 58(5), 625-646.
- [10] Cabras, I., and Higgins, D.M. (2016). Beer, brewing and business history. *Business History*, 58(5), 609-624.
- [11] Euromonitor International. (2017). Craft Beer: Coming of Age or Past Its Prime? Access on Sept 23rd 2018. Available at <https://www.euromonitor.com/craft-beer-coming-of-age-or-past-its-prime/report>.
- [12] Cervbrasil. (2018). Dados do setor cervejeiro nacional. Available online at: http://www.cervbrasil.org.br/novo_site/dados-do-setor/. Accessed: 01 sep. 2018.
- [13] Martins, L. F., Pandolfi, M. A., & Coimbra, C. C. (2017). Análise dos indicadores do mercado cervejeiro brasileiro. V Simpósio de Tecnologia da FATEC Taquaritinga. Available online at: <http://simtec.fatectq.edu.br/index.php/simtec/article/view/261>. Accessed: 01 sep. 2018.
- [14] Garavaglia, C., & Swinnen, J. (2018). Economics of the craft beer revolution: A comparative international perspective. In *Economic Perspectives on Craft Beer* (pp. 3-51). Palgrave Macmillan, Cham.
- [15] IPEA – Instituto Brasileiro de Economia Aplicada. (2012). A Década Inclusiva (2001-2011): Desigualdade, Pobreza e Políticas de Renda. Available online at: http://www.ipea.gov.br/portal/images/stories/PDFs/comunicado/120925_comunicado155rev3_final.pdf. Accessed on: September 2018.
- [16] Beni, P. F. (2017). Inovação e estratégia: um estudo no mercado de cervejas artesanais brasileiro. (Master thesis, Universidade Presbiteriana Mackenzie).
- [17] Abracerva. (2018). Associação Brasileira de Cerveja Artesanal. Online available at: <http://abracerva.com.br>. Accessed: 01 sep. 2018.
- [18] Carvalho, N. B., Minim, L. A., Nascimento, M., Ferreira, G. H. D. C., & Minim, V. P. R. (2018). Characterization of the consumer market and motivations for the consumption of craft beer. *British Food Journal*, 120(2), 378-391.
- [19] Krohn, L. V. H. (2018). Beber, fazer, vender: formação do mercado de cerveja artesanal no Brasil. (Doctoral dissertation, Universidade de São Paulo).
- [20] Chambre de Commerce et d'Industrie – CCI (2018). Parcourir notre histoire. Les dates clés du réseau. Available at <http://www.cci.fr/web/organisation-du-reseau/histoire>. Access on Sept 20th, 2018.

- [21] Monticelli, J.M. (2015). Competição, cooperação e coopeção: simetrias e discrepâncias na indústria vitivinícola do RS. *Revista de Administração da UNIMEP*, 13(2), 1-25.
- [22] Bradenburger, A. M., & Nalebuff, B. J. (1996). *Co-opetition*. Nova Iorque: Currency Doubleday.
- [23] Czakon, W., and Rogalski, M. (2014). Coopetition typology revisited – a behavioural approach. *Int. J. Business Environment*, 6(1), 28-46.
- [24] Ritala, P., Kraus, S., and Bouncken, R. B. (2016). Introduction to coopetition and innovation: contemporary topics and future research opportunities. *Int. J. Technology Management*, 71(1-2), 1-9.
- [25] Cygler, J., and Debkowska, K. (2015). Coopetition Effect Determinants: competitor's size, geographical scope, market and technological positions. *Organizacija*, 48(4), 219-231.
- [26] Salvetat, D., Geraudel, M., and D'Armagnac, S. (2013). Inter-organizational knowledge management in a cooperative context in the aeronautic and space industry. *Knowledge Management Research & Practice*, 11(3), 265–277.
- [27] Granata, J., Lasch, F., Le Roy, F., and Dna, L. (2018). How do micro-firms manage coopetition? A study of the wine sector in France. *International Journal of Small Business*. Ahead of printing.
- [28] Hamouti, R. (2016). Create alone or in cooperation: What is the best strategy for the performance of radical product innovation in the video game industry? The ISPIM Innovation Summit, Kuala Lumpur, Malaysia on 4-7 December 2016.
- [29] Maier, T. (2016). Sources of Microbrewery Competitiveness in the Czech Republic. *Agris on-line Papers in Economics and Informatics*. Volume VIII Number 4, 2016.
- [30] Kempainen, K. (2015). Competition-cooperation nexus in the European retail payments market: Views from a network industry perspective. *Journal of Payments Strategy & Systems*, 8(4), 386-394.
- [31] Sorj, B. (2008). Modos de produção e imperialismo: modelos alternativos. In: Sorj, B., Cardoso, FH., and Font, M., orgs. *Economia e movimentos sociais na América Latina*. Rio de Janeiro: Centro Edelstein de Pesquisa Social, pp. 65-113.
- [32] Lima, L. A., Fernandes, T. L., da Silva Tenório, L. X., da Silva, M. L., Evaristo, R. B. W., Ghesti, G. F., & Martin, A. R. (2017). Sinopse do cenário cervejeiro: O advento da produção e o mercado na região Centro-Oeste. *Cadernos de Prospecção*, 10(4), 650.
- [33] Thomé, K. M., Pinho, G. D. M., Fonseca, D. P., & Soares, A. B. P. (2016). Consumers' luxury value perception in the Brazilian premium beer market. *International Journal of Wine Business Research*, 28(4), 369-386.
- [34] Zobarán, E. (2017). Com inclusão no Simples Nacional, microcervejarias protegem transformação no setor. Available online at: <[https://blogs.oglobo.globo.com/saideira/post/com-](https://blogs.oglobo.globo.com/saideira/post/com-inclusao-no-simples-nacional-microcervejarias-projetam-transformacao-no-setor.html)

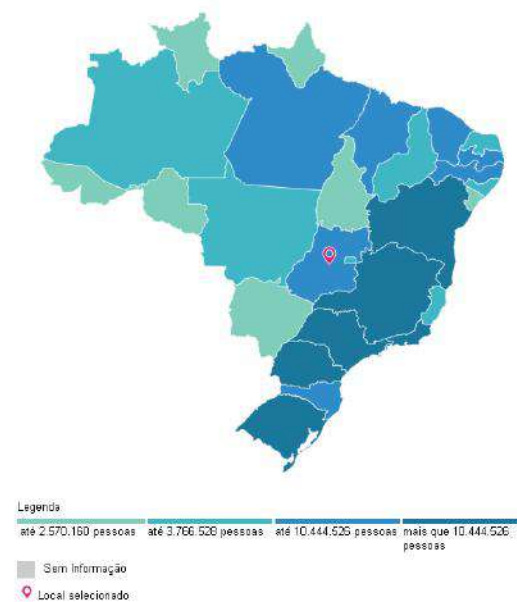
inclusao-no-simples-nacional-microcervejarias-projetam-transformacao-no-setor.html>. Accessed: 27 Jun. 2017.

Breweries

- [35] <https://www.otempo.com.br/blogs/cerveja-%C3%A9-Cultura-19.513013/Cervejaria-Cigana-%C3%A9-Alternativa-Para-Cervejeiros-Sem-F%C3%A1brica-19.1034588>
- [36] <http://Cervejariacapimbranco.Com.Br/Cervejaria-Cigana/>
- [37] https://Www.SympLa.Com.Br/Cervejarias-Ciganas-Desafios-E-Oportunidades__152416
- [38] <https://Www.Amazon.Com.Br/Mikkeller-Mikkell-Borg-Bjergs%C3%B8-Ebook/Dp/B00tu207m0>

IX. APPENDIX

Appendix 1: Location map of Goiás state in Brazil



Source: <http://cidades.ibge.gov.br/brasil/go/panorama>

Appendix 2: Time line of growth of Brahma and Antarctica breweries

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Quadro 8 – Principais investimentos da Brahma e da Antarctica nos anos 70

Empresa	Ano	Movimento	Empresa	Localização
Brahma	1971	Aquisição	Fábrica Astra	Fortaleza/CE
	1972	Associação	Fratelli Vita	Salvador/BA
	1973	Aquisição	Cibeb	Camaçari/BA
	1973	Aquisição	Miranda Corrêa	Manaus/AM
Antarctica	1974	Aquisição	Cebrasa	Anápolis/GO
	1972	Aquisição	Cervejaria Polar	Estrela/RS
		Aquisição	Cervejaria de Manaus	Manaus/AM
		Aquisição	C. Bahiana e Alimentos Ciquine	Camaçari/BA
	1973	Fusão	Cervejaria Paulista	Ribeirão Preto/SP
		Aquisição	Cervejaria Pérola	Caxias/RS
		Aquisição	Itacolomy	Pirapó/MG
		Unidades	Fábricas	Goiania/GO, Montenegro/RS, Rio de Janeiro/RJ e Viana/ES
		Unidade	Pesquisa	Manaus/AM
	1975	Unidade	Fábricas	Teresina/PI
	1977	Ampliação	Maltaria	São Paulo
1977	Unidade	Pesquisa	Paulo de Frontim/PR	

Fonte: Portal Cervesia, 2014; Gazeta Mercantil, 1997; outras fontes. Organizado pela autora.

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Quadro 9 – Principais investimentos da Brahma e da Antarctica nos anos 80

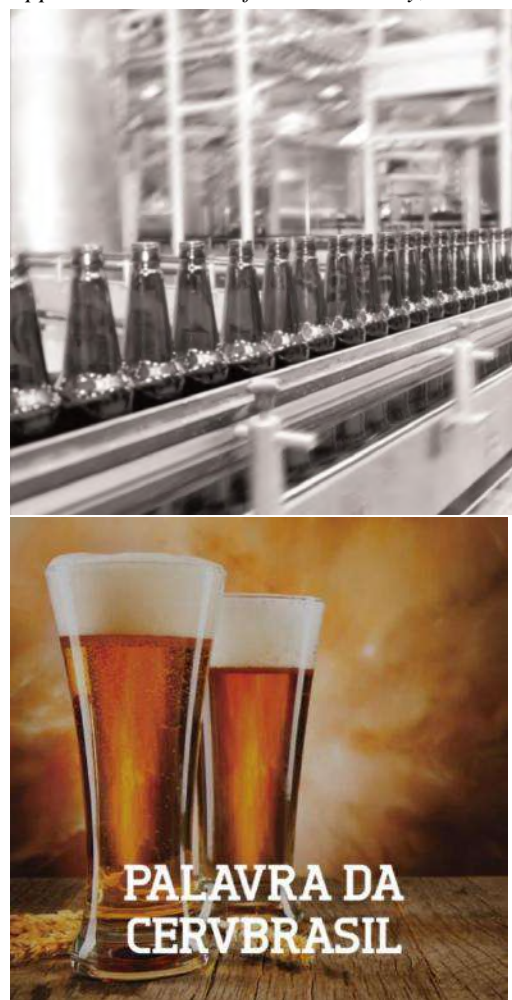
Empresa	Ano	Movimento	Empresa	Localização
Brahma	1980	Aquisição	Cervejarias Reunidas Skol/Caracu	São Paulo e Londrina/PR
	1984	Associação	Pepsico Internacional	São Paulo e Rio Grande do Sul
	1987	Unidade	Pesquisa	Rio de Janeiro
	1988/1989	Unidade	Fábrica	Jacaré/SP
Antarctica	1980	Aquisição	Cervejaria Serramalte	Getúlio Vargas e Feliz/RS
		Aquisição	Cia. Alterosa de Cervejas	Vespasiano/MG
		Associação	Arosuco	Guarulhos/RJ
	1982	Unidade	Armazenagem e beneficiamento de cevada	Lapa/PR
	1983	Unidade	Fábrica	Teresina/PI
1984	Unidade	Fábrica	João Pessoa/PB	

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	1988	Unidade	Fábrica	Rio de Janeiro
	1988/1989	Unidade	Fábricas	Jaguariúna/SP, Canoas/RS, Cuiabá/MT e Rio Grande do Norte.
	1989	Aquisição	Cerpasa	São Gonçalo/RN

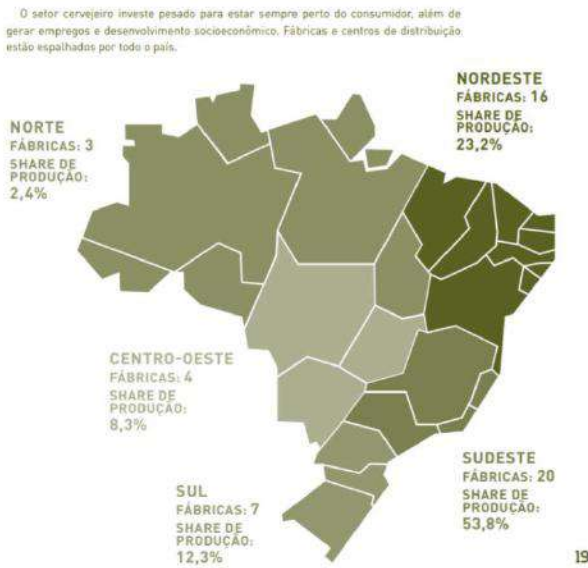
Fonte: Portal Cervesia, 2014; Gazeta Mercantil, 1997; outras fontes. Organizado pela autora.

Appendix 3: Picture of Beer Directory, 2016



Source: Anuário da Cerveja, 2016, p. 12 e 13, available at: http://www.cervbrasil.org.br/novo_site/anuarios/CervBrasil-Anuario2016_WEB.pdf

Appendix 4: Map of beer production in Brazil



Source: Anuário do Cervejeiro, 2016, p. 19, available at: http://www.cervbrasil.org.br/novo_site/anuarios/CervBrasil-Anuario2016_WEB.pdf

Appendix 5: Beer production chain in Brazil



Source: Anuário da Cerveja, 2016, p. 15, available at: http://www.cervbrasil.org.br/novo_site/anuarios/CervBrasil-Anuario2016_WEB.pdf

Russian Bear	André Natal	+55 62 929 6-389 66	https://www-1.surveio.com/survey/d/B5S5E2B2D2O1T4M0A
Vila Boa	Vandré	+55 62 965 6-865 66	https://www-1.surveio.com/survey/d/V2X5C2L7U8O4B3S5H
Pigmeu	Edgar Silva	+55 64 920 3-666 22	https://www-1.surveio.com/survey/d/F4K9K9M8K2V6Y4H6D
Corina	Marcelo Branco	+55 61 841 2-468 77	https://www-1.surveio.com/survey/d/K7R7L1L3Y4B1F4P5E
NoMoCo	Gilberto		https://www-1.surveio.com/survey/d/M2S4A7Y9L9G2D9I4D
Seresta			https://www-1.surveio.com/survey/d/K0Y8D6P3O2K8E6E3W
Tortuga			https://www-1.surveio.com/survey/d/X2S4S8W7X6I0F4S1G
Metanoia			https://www-1.surveio.com/survey/d/O3H8N0F6B1L1E1A7A
Santa Dica			https://www-1.surveio.com/survey/d/O0D2G9G5R0O6J6S5F
Bispo			https://www-1.surveio.com/survey/d/N3G9O0X6B8E0A2K5D

Appendix 6: Questionnaires sent out and contacted breweries

Brewery	Contact person	Phone	Link

What do we know about Customer Satisfaction and Loyalty? A Bibliometric Analysis

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Abstract— In this study, we explored the Status Quo of the academic literature on customer satisfaction and loyalty, and its research developments. In order to do so, we performed a bibliometric analysis from 1,358,318 scientific articles extracted from the periodical CAPES, over a period of 10 years, using three research axes. As results, we indicate some insights and research paths. Within this context, one of the main contributions of this work was to carry out research with the creation of a framework, which presents the Status Quo on customer satisfaction and loyalty. Based on these results, we propose topics that can be used in agendas for future research. These themes offer the potential to advance scientific knowledge about the relationships and interrelationships between customer satisfaction and loyalty.

Keywords — Bibliometric analysis; Structure of knowledge; Conceptual evolution; Emerging trends; Consumer behavior.

I. INTRODUCTION

In today's competitive marketplace, products and services within the same industry are becoming more and more similar. Thus, in terms of market positioning, companies have sought more differentiation that can keep them close to the customer (NOYAN; ŞİMŞEK, 2014). However, due to market competitiveness, this proximity needs to be based on customer expectations, something that should also be reviewed cyclically (NYADZAYO; KHAJEHZADEH, 2016). For this reason, Pérez and Rodriguez Del Bosque (2015) stress that consumer behavior, although complex, is an important aspect that needs to be carefully analyzed by company managers to obtain competitive advantages.

For Agnihotri et al. (2016), most often customers use and pay for services on demand without worrying about perceived value, failing to consider initial costs. In the opinion of these authors, the satisfaction generated in clients that have this posture, is highly influenced by social media. This may have the occurrence of influences from multiple sources.

However, Han and Hyun (2015) and, Ahrholdt et al. (2017) agree that customer satisfaction is the product of the judgment that is constructed during the acquisition of a service or product of a particular brand or establishment. From this, according to these authors, there is a perception about meeting expectations and, if they have been met, a loyalty behavior is generated.

According to Heskett et al. (1994), customer satisfaction is related to customer loyalty, which in turn is related to profitability. This approach is supported by Hallowell (1996), who emphasizes the practical importance of this assertion by saying that loyalty

behaviors, including continuity of relationship, result from clients' beliefs that the amount of value received from an establishment is greater than that available in others.

Sirdeshmukh et al. (2002) emphasize that satisfaction and loyalty, besides being intrinsically interconnected, can be represented by different dimensions and variables. For these authors, these dimensions and variables involve a tripartite view of reliability assessments along operational competence, operational benevolence perceived at the time of the relationship with the company, and dimensions of guidance for problem solving.

The objective of this work was to explore the scientific production on the subject of customer satisfaction and customer loyalty from a multivariate data analysis approach and, as a result, a portfolio of dimensions and variables that can guide researchers and, assist the performance of managers in planning and actions in the area.

The approaches carried out in this work resemble in part the work of Albanez et al. (2014), and Fetscherin and Heinrich (2015), regarding the methodological approach used. However, Albanez et al. (2014) limited their research universe to a specific periodical and also to the research period from 2007 to 2012. In relation to these authors, another important limitator is in the scope, which analyzed papers presented at scientific events organized in Brazil by the National Association of Postgraduate and Research in Administration (ANPAD). Both studies properly investigate customer satisfaction and loyalty; however, they are limited in scope because of sample selection. While Albanez et al. (2014) limited their study

to publications conducted by ANPAD, Fetscherin and Heinrich (2015) collected data only in the Web of Science database. This work was not limited in scope, since the data were collected on a large scale, without restricting them to any database, although there is a delimitation of the research universe. In addition, the studies of Albanez et al. (2014), and Fetscherin and Heinrich (2015) were performed in the beginning and mid-2000, emphasizing the need for a recent study.

II. CUSTOMER SATISFACTION

Commercial relations always start and have some outcome with clients (ASCARZA et al., 2017). For this reason, an understanding of how to effectively manage customer relationships has become an important topic for academics and practitioners in recent years (KELLER, 1993; Payne, FROW, 2005; RAHIMI et al., 2017). From the positioning in front of the competition and the market, through all the improvements of planning, actions and management of the organization interdepend of the clients (PARK et al., 2018). This interdependence leads companies to a need to meet the expectations that lead to the satisfaction of their demand and also of potential clients (ISTANBULLUOGLU, 2017).

For Shin and Managi (2017), customer satisfaction can be measured from the degree of perception of exceeding expectations and also from how the needs were met and delivered. In the view of Pansari and Kumar (2017), the current business market is highly competitive and having the satisfied customer is an important indicator of performance aligned with the urges of demand and business strategies.

According to Gao and Lai (2015), the experiences in terms of commercial relations experienced by the customer, form the satisfaction. However, these authors also point out that when customer satisfaction is measured, the literature only considers satisfaction, dimensions and variables based on specific satisfaction or, specific to the commercial transaction; with no agreement as to the best way to measure it.

For Olsen and Johnson (2003), perceived equity is a psychological reaction of the customer to the value that a service company offers. These authors also point out that, this equity fosters customer satisfaction, which can be described as cumulative satisfaction, from business relationships. It is also highlighted that, from this, clients tend to rely on all their experience, forming intentions and repurchase decisions. This view is corroborated by Ashraf et al. (2018), which define customer satisfaction as one of the main objectives of organizations. According to these authors, satisfaction leads customers to be loyal, and this can be a source of competitive advantage for the organization.

For organizations to position themselves adequately in the face of market and demand, in order to obtain sustainable competitive advantage, it is necessary to provide and improve customer satisfaction (PORTER, 2011). Due to this positioning, Aktepe et al. (2015), advocate the need to constantly carry out an analysis of customer satisfaction and, from this, review plans and actions. According to these authors, this analysis should be used as a parameter to measure levels of customer satisfaction. And, as a result of this action, take actions contrary to the points of low satisfaction detected and, also, improving the points of high satisfaction.

Pan (2015) presents another point of view that satisfaction can be measured by feedback from customers on the quality and evaluation of the products or services themselves or products. For this author, customer satisfaction is an element that can be considered erratic, this is justified because a product or service satisfies a customer and necessarily may not satisfy another. Therefore, according to Ashraf et al. (2018), in order to increase customer satisfaction, it is necessary that the dimensions and variables that influence customer satisfaction are correctly understood.

The search for an effective management of the elements that generate satisfaction and, the improvement of customer loyalty, has been approached by professionals and by the literature (ZEITHAML et al., 1993; RUST, CHUNG, 2006; BLUT et al., 2015). Several studies have found that the higher level of customer satisfaction leads to greater fidelity and, therefore, word of mouth recommendations (BODET, 2008; DENG et al., 2010; OREL; KARA, 2014; MEESALA; PAUL, 2018). The expansion of competition in the marketing of products and services has led companies to reflect on differentiating strategies that foster loyalty and, from this, attract and retain customers (OPREANA, VINERIAN, 2015). However, Kumar et al. (2013) emphasize the existence of an intrinsic association between customer satisfaction and loyalty, which is highly variable and also dependent on dimensions and variables that compose the most varied scenarios. According to these authors, this association still influences the type of sector involved and the segment of clients, which, therefore, influence the nature of the variables.

III. LOYALTY OF CUSTOMERS

It can be well accepted today that competitiveness in terms of quantity and quality makes it extremely difficult for a company to differentiate itself from its competitors (NGO; NGUYEN, 2016). This, according to Alotaibi (2015), can be measured through customer loyalty, which is both an attitudinal and behavioral tendency that favors the choice of one brand over all others. For Ngo and

Nguyen (2016), for reasons of cost reduction and profit improvement, in order to build sustainable competitiveness, maintaining long-term customer loyalty is a mandatory task of organizations.

In this paper, we present the results of a study of customer loyalty (DICK, BASU, 1994; ZEITHAMLETAL et al., 1993; REICHHELD, 2003). However, Nyadzayo and Khajehzadeh (2016) emphasize that while managers take a continuous approach and emphasize planning and action that drives customer loyalty, this approach remains one of the most challenging issues facing modern day-to-day business, due to the intense breadth and market competition.

Machado (2015) emphasizes that if the customer buys the same brand regularly, it is possible to consider him a loyal customer to this brand. This author further expands this view by pointing out that a constant repurchase of the same brand may be termed trademark behavioral loyalty. This behavioral issue, according to Ngo and Nguyen (2016), occurs when a customer considers that the product or service provided by an organization remains the most appropriate alternative among so many others available in the market. According to these authors, the behavioral loyalty to brands is the one that best meets the needs, expectations and values of this client.

Customer loyalty encourages consumers to buy more consistently, and also more cyclically, by spending a larger portion of money and thus having a positive feeling about shopping experiences, helping to attract other consumers (KASIRI et al. al., 2017; LIU; ATUAHENE-GIMA, 2018). Due to this feeling, customer loyalty as the main consequence of customer satisfaction, has several ways of being defined and measured (Wright et al., 2017, Gong, YI, 2018). According to Khuong and Dai (2016), if a company invests resources to increase customer loyalty without focusing on profitability, such long-term action can lead to failures in its sustainability vis-à-vis the market.

Although customer loyalty is often related to the predisposition of shopping repeatedly (ALOTAIBI, 2015;

NGO; NGUYEN, 2016), according to Ismail and Yunan (2016), a good or service to ensure customer loyalty, needs to be accompanied by some psychological bond, and the organization must simultaneously maintain attitudes favorable to an ongoing relationship.

For Chuah et al. (2016), organizations need to establish cycles of change and manage customer satisfaction in order to retain them strategically. However, according to these authors, although these cycles may be effective in generating customer loyalty, however, they are not a suitable instrument for changing dissatisfactions when they occur.

Customer loyalty over time has been studied intensively, and has sought to identify and understand dimensions and variables that lead a consumer to become loyal, as well as the factors that make him break a loyalty relationship with a particular brand or consequences of these situations (VISENTINI, FENNER, 2017).

IV. DEVELOPMENT OF THE METHODOLOGICAL APPROACH AND RESULTS

This article was structured as a result of the investigation of the scientific production related to customer satisfaction and loyalty, with the subsequent analysis of quantitative data on works present in the literature, which were allocated in research axes to observe interfaces in these works.

Within this context, bibliometrics, which is a mechanism for reviewing scientific production, can be considered as systematic, comprehensible and reproducible, allowing a broader understanding of scientific and technological information (FETSCHERIN; HEINRICH, 2015). For this reason, and considering the assumptions presented in this section, the methodological approach of this work employed three stages (Structuring the research framework, Study for research portfolio composition and Bibliometric analysis of the research portfolio) to investigate scientific production related to satisfaction and customer loyalty (Figure 1).



Fig. 1: Synthesis of the methodological approach used

The structuring of the research framework was started from the definition of research axes. In this work three

central axes were defined to investigate the literature. Thus, the first research axis was defined from the

Table.2: Compilation of initial search results

R ₁	Research axes (R _n)			Data base		
	R ₂	R ₃		Springer	Sciencedirect	Emerald
Multivariate data analysis	Customer expectations	Performance		28	179	65
		Customization		5	29	2
		Quality		26	197	69
		Marketing		23	145	50
		Profitability		7	66	28
Multivariate data analysis	Consumer satisfaction	Performance		10	171	33
		Customization		4	28	3
		Quality		12	234	35
		Marketing		11	194	29
		Profitability		5	58	16
Multivariate data analysis	Consumer loyalty	Performance		3	92	14
		Customization		1	17	1
		Quality		3	125	15
		Marketing		3	131	14
		Profitability		3	37	8
Total				144	1703	382

The next step in the composition of the research portfolio was to carry out a sorting of duplicate articles, which was carried out using Zotero software. In this way, all articles found (Table 2) were imported into the software operation platform, with a repetition of 1685

articles identified. Subsequently, these articles were deleted from the research portfolio, leaving a quantitative of 544 articles.

Table.3: Selected articles from the title and abstract

Author(s)	Title	Citations
Talib et al. (2013)	An empirical investigation of relationship between total quality management practices and quality performance in Indian service companies.	153
Jiewanto et al. (2012)	Influence of Service Quality, University Image, and Student Satisfaction toward WOM Intention: A Case Study on Universitas Pelita Harapan Surabaya.	82
Herrmann et al. (2006)	An empirical study of quality function deployment on company performance	49
Ramseook-Munhurrun et al. (2015)	Examining the Structural Relationships of Destination Image, Perceived Value, Tourist Satisfaction and Loyalty: Case of Mauritius.	89
Wang e Tseng (2011)	Evaluation of International Student Satisfaction using Fuzzy Importance-Performance Analysis	26
Ferreira et al. (2010)	Efeitos da responsabilidade social corporativa na intenção de compra e no benefício percebido pelo consumidor: um estudo experimental	18
Noor e Foo (2014)	Determinants of Customer Satisfaction of Service Quality: City Bus Service in Kota Kinabalu, Malaysia.	29
Abdullah (2013)	Fuzzy multi criteria decision making and its applications: A brief review of category.	35
Gil et al. (2010)	Las asociaciones de la imagen como determinantes de la satisfacción en el sector bancario español.	18
Fuentes-Blasco et al. (2014)	Effect of customer heterogeneity on the relationship satisfaction-loyalty.	26
Gregorio e Cronemyr (2011)	From expectations and needs of service customers to control chart specification limits.	17
Camgoz-Akdag e Zaim (2012).	Education: a comparative structural equation modeling study.	13
Šályová et al. (2015)	Effect of Marketing Orientation on Business Performance: A Study from Slovak Foodstuff Industry.	19
Radomir e Nistor (2012)	High-Educated Consumer Perceptions of Service Quality: An Assessment of the SSTQUAL Scale in the Romanian Banking Industry.	14

Thus, after filtering and deleting duplicate articles, a check of the adherence to the topic customer satisfaction and loyalty was performed in all 544 articles, by means of title and abstract reading. This verification allowed us to locate 507 articles that were not aligned with the topic, which were removed from the scope of the study. Proceeding, as suggested by Hicks et al. (2015), a verification of the scientific recognition of the remaining

articles was carried out. And, in this way, the other 37 publications were analyzed for scientific recognition. The purpose of this analysis was to select the most relevant literature, with two cut-off stages, the first one based on the pre-established value of 85%, that is, articles whose quotations represent 85% of the sum of all quotes in the portfolio, were selected and, below that margin, were removed from the analysis process. The second cut phase,

according to Hicks (2015), considered as included in the methodological approach, articles that were cited 12 times or more, being withdrawn to those below this level (Table 3). In order to aid in the operationalization of these searches and citation checks, the Google Scholar search tool was used.

However, as Fetscherin and Heinrich (2015) point out, a bibliometric analysis must be able to indicate the real paths that the academy has been following. For this reason, a new verification of adherence of the selected articles to the subject of customer satisfaction and loyalty was carried out, and a full reading of contents was carried out. From this, 9 articles were excluded from the framework of Table 3, due to the absence of adherence. Thus, after the previous studies, where 2229 literatures were considered, the final portfolio of articles adhering to the theme studied was obtained (Table 4).

Table.4: Composition of the final portfolio

Author(s)	Citations
Jiewanto et al. (2012)	82
Ramseook-Munhurrun et al. (2015)	89
Wang e Tseng (2011)	26
Abdullah (2013)	35
Camgoz-Akdag e Zaim (2012).	13

Sequentially, the bibliometric analysis was started, considering all the articles that compose the final portfolio and their respective citations (250 articles). This analysis followed the precepts of Hicks et al. (2015), which suggest as parameters of the literature, the year of publication, the country of origin, and the interrelations between the literatures of a field of study. Thus, from the analysis of the 250 articles, 45 different countries were identified, 9 temporal periods of publications between 2010-2018 (Figure 3), and several interrelations between literatures.

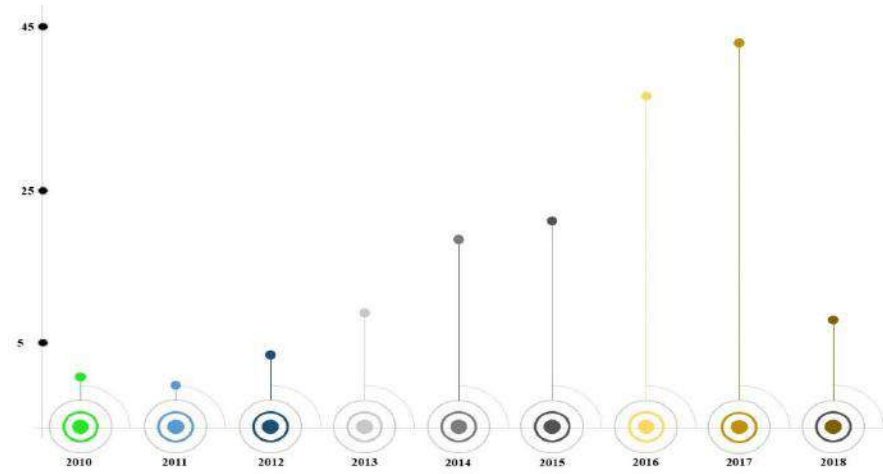


Fig. 3: Time Synthesis of Publication Behavior

Figure 3 shows the evolution of the number of articles published per year. The year with the most articles published is 2017, with forty-four articles; followed by 2016 with forty-one; 2015 with twenty-three; 2014 with twenty; 2018 with fourteen; 2013 with ten; 2012 with five of us; 2011 with an article published in the scientific journals indexed in the three databases researched. The annual average of the scientific production on the subject is 19.5 articles / year, fact that indicates the relevance and discussions in the literature. With this, it is evaluated that the scientific production on satisfaction and customer loyalty is still moderate and, it needs more researchers interested in the subject.

Figure 3 shows the evolution of the number of articles published per year. The year with the most articles published is 2017, with forty-four articles; followed by 2016 with forty-one; 2015 with twenty-three; 2014 with twenty; 2018 with fourteen; 2013 with ten; 2012 with five of us; 2011 with an article published in the scientific

journals indexed in the three databases researched. The annual average of the scientific production on the subject is 19.5 articles / year, fact that indicates the relevance and discussions in the literature. With this, there is an indication that scientific output on customer satisfaction and loyalty is still moderate. However, in ascertaining the results that Figure 3 presents, it is possible to notice that in the period comprising the years 2010 and 2011, the publications were scarce, however, after that period an increasing pattern of publications is also denoted.

Thus, as of 2011, this evolution on investigations regarding the subject of customer satisfaction and loyalty, suggests a recognition of the importance of knowing the needs and expectations of the clients with greater rigor. This can be verified through the cumulative regression of the publication behavior (Figure 4), where the obtained value of R^2 (0.96092) suggests that the adjustment of the model can explain the observed values and that the statistical conditions are adequate to confirm that the

number of publications can lead to a growing on the subject customer satisfaction and loyalty.

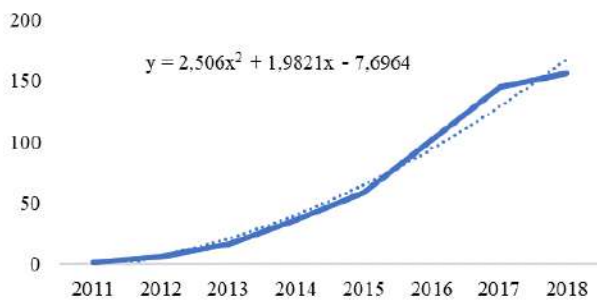


Fig. 4: Trend analysis of publications

In addition, Figure 5 shows the countries of origin of the published articles on customer satisfaction and loyalty, which were almost identified from the research axes (Table 2).

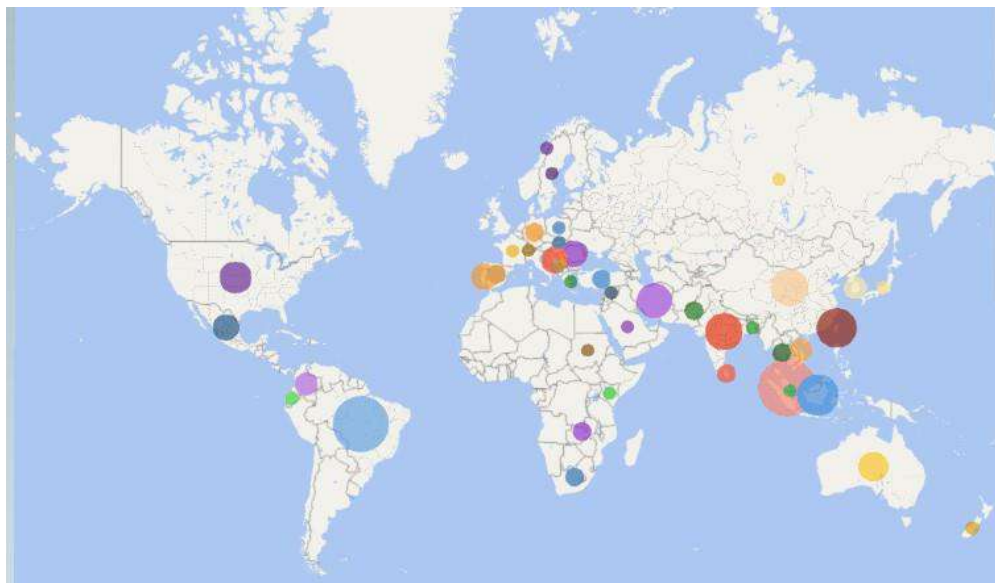


Fig. 5: Academic productivity by country

We identified 154 publications, with an average of 3 articles per country. Three countries (Brazil, Indonesia and Malaysia) contributed with 30.5% of the publications. The other countries, including South Africa, Germany, Australia, Mexico and England, for example, published on average two scientific papers each in the period analyzed. It is also noted that there are countries considered to be emerging, or in development, are publishing studies on the subject, such as Singapore, South Korea, India, Thailand and Indonesia. Although the number of publications has increased by approximately

48% since 2007, which suggests an awakening by customer satisfaction and loyalty studies, compared to other areas of knowledge, however, efforts are needed to increase and research related to customer satisfaction and loyalty.

The investigation of the interrelation between citations was made through the analysis of social networks (Figure 6), which made it possible to graphically visualize interactions among the selected literatures (Table 4), making it possible to note occurrences of relations, as well as their amplitudes.

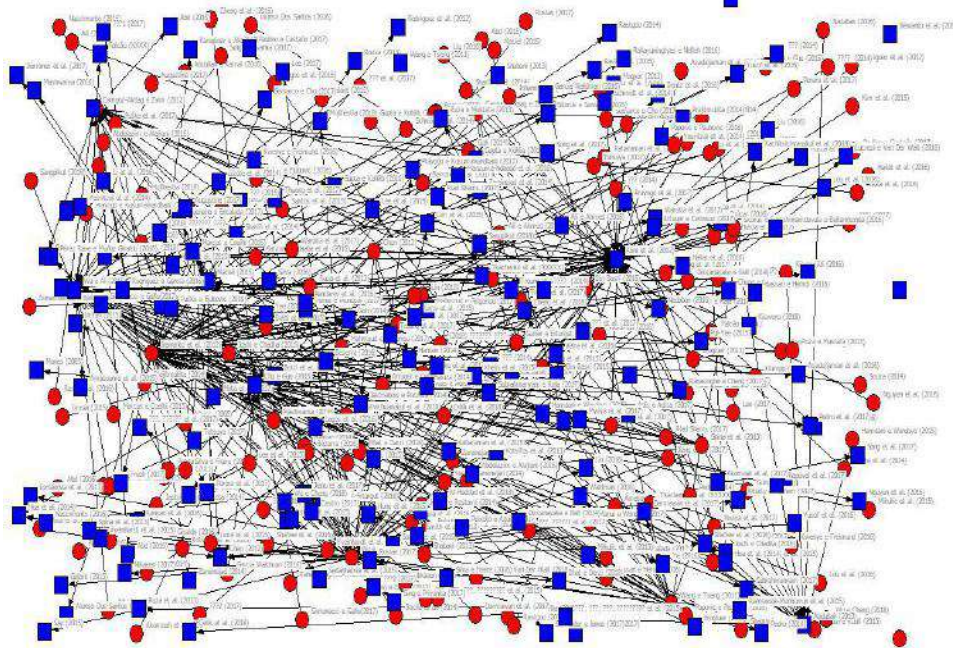


Fig. 6: Cluster structure of the citation network

The results show that, although the macroenvironment is characterized by several links, there is insufficient evidence to support the existence of a specific type of pattern or differentiate. Thus, these results also give rise to the existence that the analyzed literature has a wide influence among them. However, to broaden the reflections on the understanding of this existence, a polarization of components of social networks was made (Figure 7).

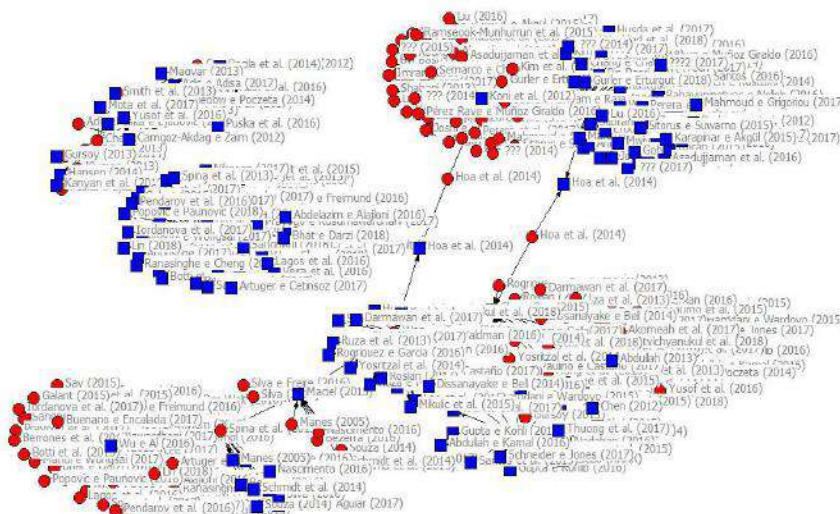


Fig. 7: Polarized cluster structure of the citation network

When the polarization of the network of citations was realized (Figure 7), isolated environments were revealed in comparison to the initial cluster. And, from this revelation, it was also possible to verify that the connections between these environments are tenuous,

suggesting the existence of little interrelation between the citations of the themes contained in the literatures of the final portfolio. From these links were identified the seven literatures that aided this polarization (Table 5).

Table.5: Synthesis of the literature used to support the polarization of the network of citations

Author(s)	Method, technique and /or tools	Application
Abdullah (2013)	<i>Fuzzy logic and Multicriteria method</i>	Decision making about consumer purchasing positioning.
Chen (2012)	<i>Fuzzy logic and Structural Equation Modeling</i>	Analysis of the repurchase rate to maximize services.
Ramseook-Munhurrun et al. (2015)	<i>Structural Equation Modeling</i>	Appreciation of constructs that influence the satisfaction and loyalty of tourists.
Jiewanto et al. (2012)	<i>Structural Equation Modeling</i>	Verification of the influence of quality parameters on the university service offer.
Wang e Tseng (2011)	<i>Fuzzy Importance-Performance Analysis</i>	Examine the dynamics that attract foreign students to higher education.
Cangoz-Akdag e Zaim (2012)	<i>Structural Equation Modeling</i>	To verify satisfaction based on the identification of variables that determine perceived quality.
Spina et al. (2013)	<i>Survey and Quality tool</i>	Evaluation of the relationship between quality and customer satisfaction.

Customer satisfaction and loyalty are areas that are complex enough to include multiple variables, which are and are, most of the time, interrelated and mutually dependent. For this reason, the efforts of the scientific community so far have been directed to the investigation and identification of these variables, as well as the relationships between them and their influence on and for the client.

V. FINAL CONSIDERATIONS

The bibliometric analysis of customer satisfaction and loyalty in this work examined the evolution of scientific production over a 10-year period, based on academic publication observations. From our analysis, we conclude that literature reviews on client satisfaction and loyalty are limited to the presentation of some context. The increase in the number of publications that has as its starting point contexts related to customer satisfaction and loyalty, suggests the interest and relevance of this work and, from this, the indication of existing gaps in the literature. Therefore, some insights and research paths are indicated. For example, a positive growth trend has been observed since 2007 and the number of publications has reached 45 in 2017. A plausible explanation for this trend can be supported by the recession and in the period of economic slowdown that businesses and enterprises faced.

However, the investigations showed that client satisfaction and loyalty is moderately exploited in the scientific environment, reflecting perspectives that present multidimensional quantitative approaches. Thus, this context may still have an investigative continuity, in which evidence tends to emerge and, from them ramifications in several areas of research, which perpass topics related to customer satisfaction and loyalty.

It is therefore not surprising that the number of high-impact publications, and thus the journals dealing with

this subject, is still small. However, the results of our inquiries shed light on a relatively new area of research, however, fascinating about the interrelationships existing between clients and dimensions and variables that influence the feeling of satisfaction and loyalty.

One of the main contributions of this work was the realization of research with subsequent creation of a framework, which presents the status quo and the indications of paths of literature on the researched topic, drawn from comprehensive literature review. These findings may be used for further research on the subject and other related topics of interest to the academy.

Other important findings are related to the most common methods applied and the data sources employed. Thus, analyzing the final literature portfolio, the most frequent search methods were multivariate data analysis and quantitative data collection, these methods were based on semi-structured interviews and surveys using closed questionnaires.

The research limitations of this work are related to the focus of publications and databases present in the CAPES Newspapers platform. Thus, it is suggested for future researches: (i) the replication to other contexts from annals of congresses, theses, dissertations and books; (ii) the expansion of bibliometric analysis through the use of other databases of scientific publications and, consequently, the identification of scientific research gaps.

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REFERENCES

- [1] Abdullah, L. Fuzzy multi criteria decision making and its applications: A brief review of category. (2013). *Procedia-Social and Behavioral Sciences*, 97, 131-136.
- [2] Agnihotri, R., Dingus, R., Hu, M. Y. and Krush, M. T. (2016). Social media: Influencing customer satisfaction in B2B sales. *Industrial Marketing Management*, 53, 172-180.
- [3] Ahrholdt, D. C., Gudergan, S. P. and Ringle, C. M. (2017). Enhancing service loyalty: The roles of delight, satisfaction, and service quality. *Journal of Travel Research*, 56(4), 436-450.
- [4] Aktepe, A., Ersöz, S. and Toklu, B. (2015). Customer satisfaction and loyalty analysis with classification algorithms and Structural Equation Modeling. *Computers & Industrial Engineering*, 86, 95-106.
- [5] Albanez, J. A. P. A., Garcia, S. F. A. G. and Galli, L. C. L. A. (2014). Métodos de pesquisa e satisfação de clientes: um estudo bibliométrico. *Brazilian Journal of Marketing, Opinion, and Media Research*, 16, 1-27.
- [6] Ali, F., Kim, W. G., Li, J., and Jeon, H. M. (2018). Make it delightful: Customers' experience, satisfaction and loyalty in Malaysian theme parks. *Journal of destination marketing & management*, 7, 1-11.
- [7] Alotaibi, M. M. (2015). Evaluation of "AIRQUAL" scale for measuring airline service quality and its effect on customer satisfaction and loyalty. 210f. Thesis (Doctorate in Transportation Management) - School of Aerospace, Transport and Manufacturing, Cranfield University, Cranfield, England.
- [8] Anderson, E. W., Fornell, C. and Lehmann, D. R. (1994). Customer satisfaction, market share, and profitability: Findings from Sweden. *Journal of marketing*, 58(3), 53-66.
- [9] Ascarza, E., Ebbes, P., Netzer, O. and Danielson, M. (2017). Beyond the target customer: Social effects of customer relationship management campaigns. *Journal of Marketing Research*, 54(3), 347-363.
- [10] Ashraf, S., Ilyas, R., Imtiaz, M. and Ahmad, S. (2018). Impact of Service Quality, Corporate Image and Perceived Value on Brand Loyalty with Presence and Absence of Customer Satisfaction: A Study of four Service Sectors of Pakistan. *International Journal of Academic Research in Business and Social Sciences*, 8(2), 452-474.
- [11] Baker, D. A. and Crompton, J. L. (2000). Quality, satisfaction and behavioral intentions. *Annals of tourism research*, 27(3), 785-804.
- [12] Blut, M., Frennea, C. M., Mittal, V. and Mothersbaugh, D. L. (2015). How procedural, financial and relational switching costs affect customer satisfaction, repurchase intentions, and repurchase behavior: a meta-analysis. *International Journal of Research in Marketing*, 32(2), 226-229.
- [13] Bodet, G. (2008). Customer satisfaction and loyalty in service: Two concepts, four constructs, several relationships. *Journal of retailing and consumer services*, 15(3), 156-162.
- [14] Bolton, R. N. and Drew, J. H. (1991). A multistage model of customers' assessments of service quality and value. *Journal of consumer research*, 17(4), 375-384.
- [15] Camgoz-Akdag, H. and Zaim, S. (2012). Education: a comparative structural equation modeling study. *Procedia-Social and Behavioral Sciences*, 47, 874-880.
- [16] Carman, J. M. (1990). Consumer perceptions of service quality: an assessment of the SERVQUAL dimensions. *Journal of retailing*, 66(6), 33-55.
- [17] Chen, S. C. (2012). Fuzzy cognitive map for optimizing solutions for retaining full-service restaurant customer. *Procedia-Social and Behavioral Sciences*, 57, 47-52.
- [18] Chuah, S. H. W., Marimuthu, M., and Ramayah, T. (2016). The Contribution of Perceived Firm Marketing Innovation Initiatives to Customer Perceived Value and Loyalty: Does Switching Experience Really Matter? *Asian Academy of Management Journal*, 21(1), 1-23.
- [19] Cronin Jr., J. J. and Taylor, S. A. (1994). SERVPERF versus SERVQUAL: reconciling performance-based and perceptions-minus-expectations measurement of service quality. *Journal of marketing*, 58(1), 125-131.
- [20] Delgado-Ballester, E. and Munuera-Alemán, J. L. Brand trust in the context of consumer loyalty. *European Journal of marketing*, 35(11/12), 1238-1258.
- [21] Deng, Z., Lu, Y., Wei, K. K. and Zhang, J. (2010). Understanding customer satisfaction and loyalty: An empirical study of mobile instant messages in China. *International journal of information management*, 30(4), 289-300.
- [22] Diaz-Martin, A. M., Iglesias, V., Vazquez, R. and Ruiz, A. V. (2000). The use of quality expectations to segment a service market. *Journal of Services Marketing*, 14(2), 132-146.
- [23] Dick, A. S. and Basu, K. (1994). Customer loyalty: toward an integrated conceptual framework. *Journal of the academy of marketing science*, 22(2), 99-113.
- [24] Ferreira, D. A., Ávila, M. and Faria, M. D. (2010). Efeitos da responsabilidade social corporativa na intenção de compra e no benefício percebido pelo consumidor: um estudo experimental. *Revista de Administração*, 45(3), 285-296.
- [25] Fetscherin, M. and Heinrich, D. (2015). Consumer brand relationships research: A bibliometric citation meta-analysis. *Journal of Business Research*, 68(2), 380-390.
- [26] Fuentes-Blasco, M., Moliner-Velázquez, B. and Gil-Saura, I. (2014). Effect of customer heterogeneity on the relationship satisfaction-loyalty. *Revista Española de Investigación de Marketing ESIC*, 18(2), 78-92.
- [27] Gao, B. W. and Lai, I. K. W. (2015). The effects of transaction-specific satisfactions and integrated satisfaction on customer loyalty. *International journal of hospitality management*, 44, 38-47.
- [28] Giese, J. L. and Cote, J. A. (2000). Defining consumer satisfaction. *Academy of marketing science review*, 1(1), 1-22.
- [29] Gil, R. B., Vallejo, J. M. and Pérez, J. M. P. (2010). Las asociaciones de la imagen como determinantes de la satisfacción en el sector bancario español. *Cuadernos de Economía y Dirección de la Empresa*, 13(43), 9-35.
- [30] Gilbert, D. and Wong, R. K. C. (2003). Passenger expectations and airline services: a Hong Kong based study. *Tourism Management*, 24(5), 519-532.

- [31] Gong, T. and Yi, Y. (2018). The effect of service quality on customer satisfaction, loyalty, and happiness in five Asian countries. *Psychology & Marketing*, 35(6), 427-442.
- [32] Gregorio, R. and Cronemyr, P. (2011). From expectations and needs of service customers to control chart specification limits. *The TQM Journal*, 23(2), 164-178.
- [33] Hallowell, R. (1996). The relationships of customer satisfaction, customer loyalty, and profitability: an empirical study. *International journal of service industry management*, 7(4), 27-42.
- [34] Han, H. and Hyun, S. S. (2015). Customer retention in the medical tourism industry: Impact of quality, satisfaction, trust, and price reasonableness. *Tourism Management*, 46, 20-29.
- [35] Hellier, P. K., Geursen, G. M., Carr, R. A. and Rickard, J. A. (2003). Customer repurchase intention: A general structural equation model. *European journal of marketing*, 37(11/12), 1762-1800.
- [36] Herrmann, A., Huber, F., Algesheime, R. and Tomczak, T. (2006). An empirical study of quality function deployment on company performance. *International Journal of Quality & Reliability Management*, 23(4), 345-366.
- [37] Heskett, J. L., Jones, T. O., Loveman, G. W., Sasser, W. E. and Schlesinger, L. A. (1994). Putting the service-profit chain to work. *Harvard business review*, 72(2), 164-174.
- [38] Hicks, D., Wouters, P., Waltman, L., Rijcke, S. and Rafols, I. (2015). Bibliometrics: the Leiden Manifesto for research metrics. *Nature News*, 520(7548), 429-431.
- [39] Hur, W. M., Moon, T. W. and Jung, Y. S. (2015). Customer response to employee emotional labor: the structural relationship between emotional labor, job satisfaction, and customer satisfaction. *Journal of Services Marketing*, 29(1), 71-80.
- [40] Iacobucci, D., Ostrom, A. and Grayson, K. (1995). Distinguishing service quality and customer satisfaction: the voice of the consumer. *Journal of consumer psychology*, 4(3), 277-303.
- [41] Ismail, A. and Yunan, Y. M. (2016). Service quality as a predictor of customer satisfaction and customer loyalty. *LogForum*, 12(4), 269-283.
- [42] Istanbuluoglu, D. (2017). Complaint handling on social media: The impact of multiple response times on consumer satisfaction. *Computers in Human Behavior*, 74, 72-82.
- [43] Jiewanto, A., Laurens, C. and Nelloh, L. (2012). Influence of service quality, university image, and student satisfaction toward WOM intention: A case study on Universitas Pelita Harapan Surabaya. *Procedia-Social and Behavioral Sciences*, 40, 16-23.
- [44] Keller, K. L. (1993). Measuring, and Managing Customer-Based Brand Equity. *Journal of Marketing*, 57(1), 1-22.
- [45] Kelley, S. W. and Davis, M. A. (1994). Antecedents to customer expectations for service recovery. *Journal of the Academy of Marketing Science*, 22(1), 52-61.
- [46] Khuong, M. N. and Dai, N. Q. (2016). The Factors Affecting Customer Satisfaction and Customer Loyalty - A Study of Local Taxi Companies in Ho Chi Minh City, Vietnam. *International Journal of Innovation, Management and Technology*, 7(5), 228-233.
- [47] Kumar, V., Dalla Pozza, I. and Ganesh, J. (2013). Revisiting the satisfaction-loyalty relationship: empirical generalizations and directions for future research. *Journal of Retailing*, 89(3), 246-262.
- [48] Liu, W. and Atuahene-Gima, K. (2018). Enhancing product innovation performance in a dysfunctional competitive environment: The roles of competitive strategies and market-based assets. *Industrial Marketing Management*, 73, 7-20.
- [49] Machado, R. W. R. (2015). A relação entre confiança, satisfação e lealdade: estudo de mercado de seguros. 99f. Dissertation (Master in Business Administration) - Faculty of Business Sciences, FUMEC University, Belo Horizonte, Brasil.
- [50] Mackay, K. J. and Crompton, J. L. (1988). A conceptual model of consumer evaluation of recreation service quality. *Leisure Studies*, 7(1), 40-49.
- [51] Mckinney, V., Yoon, K. and Zahedi, F. M. (2002). The measurement of web-customer satisfaction: An expectation and disconfirmation approach. *Information systems research*, 13(3), 296-315.
- [52] Meesala, A. and Paul, J. (2018). Service quality, consumer satisfaction and loyalty in hospitals: Thinking for the future. *Journal of Retailing and Consumer Services*, 40, 261-269.
- [53] Ngo, V. M. and Nguyen, H. H. (2016). The relationship between service quality, customer satisfaction and customer loyalty: An investigation in Vietnamese retail banking sector. *Journal of Competitiveness*, 8(2), 103-116.
- [54] Noor, H. M. and Foo, J. (2014). Determinants of customer satisfaction of service quality: City bus service in Kota Kinabalu, Malaysia. *Procedia-Social and Behavioral Sciences*, 153, 595-605.
- [55] Noyan, F. and Şimşek, G. G. (2014). The antecedents of customer loyalty. *Procedia-Social and Behavioral Sciences*, 109, 1220-1224.
- [56] Nyadzayo, M. W. and Khajehzadeh, S. (2016). The antecedents of customer loyalty: A moderated mediation model of customer relationship management quality and brand image. *Journal of Retailing and Consumer Services*, 30, p. 262-270.
- [57] OLIVER, R. L. (1999). Whence consumer loyalty? *Journal of marketing*, 63(4), 33-44.
- [58] Olsen, L. L. and Johnson, M. D. (2003). Service equity, satisfaction, and loyalty: from transaction-specific to cumulative evaluations. *Journal of Service Research*, 5(3), 184-195.
- [59] Opreana, A. and Vinerean, S. (2015). A new development in online marketing: Introducing digital inbound marketing. *Expert Journal of Marketing*, 3(1), 29-34.
- [60] Orel, F. D. and Kara, A. (2014). Supermarket self-checkout service quality, customer satisfaction, and loyalty: Empirical evidence from an emerging market. *Journal of Retailing and Consumer Services*, 21(2), 118-129.
- [61] Ostrom, A. and Iacobucci, D. (1995). Consumer trade-offs and the evaluation of services. *Journal of marketing*, 59(1), 17-28.
- [62] Pan, F. C. (2015). Practical application of importance-performance analysis in determining critical job

- satisfaction factors of a tourist hotel. *Tourism Management*, 46, 84-91.
- [63] Pansari, A. and Kumar, V. (2017). Customer engagement: the construct, antecedents, and consequences. *Journal of the Academy of Marketing Science*, 45(3), 294-311.
- [64] Parasuraman, A., Berry, L. L. and ZEITHAML, V. A. (1991). Understanding customer expectations of service. *Sloan management review*, 32(3), 39-48.
- [65] _____. (1994). Reassessment of expectations as a comparison standard in measuring service quality: implications for further research. *Journal of marketing*, 58(1), 111-124.
- [66] Park, S., Hahn, S., Lee, T. and Jun, M. (2018). Two factor model of consumer satisfaction: International tourism research. *Tourism Management*, 67, 82-88.
- [67] Payne, A. and Frow, P. (2005). A strategic framework for customer relationship management. *Journal of marketing*, 69(4), 167-176.
- [68] Pérez, A. and Rodriguez Del Bosque, I. (2015). Corporate social responsibility and customer loyalty: exploring the role of identification, satisfaction and type of company. *Journal of Services Marketing*, 29(1), 15-25.
- [69] Pleger Bebko, C. (2000). Service intangibility and its impact on consumer expectations of service quality. *Journal of Services Marketing*, 14(1), 9-26.
- [70] Porter, M. E. (2011). *Competitive advantage of nations: creating and sustaining superior performance*. 2nd. New York: Simon and Schuster.
- [71] Radomir, L. and Nistor, C. V. (2012). High-educated consumer perceptions of service quality: an assessment of the SSTQUAL scale in the Romanian banking industry. *Procedia Economics and Finance*, 3, 858-864.
- [72] Rahimi, R., Köseoglu, M. A., Ersoy, A. B. and Okumus, F. (2017). Customer relationship management research in tourism and hospitality: a state-of-the-art. *Tourism Review*, 72(2), 209-220.
- [73] Ramseook-Munhurrin, P., Seebaluck, V. N. and Naidoo, P. (2015). Examining the structural relationships of destination image, perceived value, tourist satisfaction and loyalty: case of Mauritius. *Procedia-Social and Behavioral Sciences*, 175, 252-259.
- [74] Reichheld, F. F. (2003). The one number you need to grow. *Harvard business review*, 81(12), 46-55.
- [75] Rust, R. T. and Chung, T. S. (2006). Marketing models of service and relationships. *Marketing Science*, 25(6), 560-580.
- [76] Šályová, S., Tábořecká-Petrovičová, J., Nedelová, G. and Ďaďo, J. (2015). Effect of marketing orientation on business performance: A study from Slovak foodstuff industry. *Procedia Economics and Finance*, 34, 622-629.
- [77] Shin, K. J. and Managi, S. (2017). Liberalization of a retail electricity market: Consumer satisfaction and household switching behavior in Japan. *Energy Policy*, 110, 675-685.
- [78] Sirdeshmukh, D., Singh, J. and Sabol, B. (2002). Consumer trust, value, and loyalty in relational exchanges. *Journal of marketing*, 66(1), 15-37.
- [79] Spina, D. T., Giraldi, J. M. E. and Oliveira, M. M. B. (2013). A influência das dimensões da qualidade de serviços na satisfação do cliente: um estudo em uma empresa do setor de controle de pragas. *REGGE Revista de Gestão*, 20(1), 93-112.
- [80] Swartz, T. A. and brown, S. W. (1989). Consumer and provider expectations and experiences in evaluating professional service quality. *Journal of the Academy of Marketing Science*, 17(2), 189-195.
- [81] Talib, F., Rahman, Z. and Qureshi, M. N. (2013). An empirical investigation of relationship between total quality management practices and quality performance in Indian service companies. *International journal of quality & reliability management*, 30(3), 280-318.
- [82] Teas, R. K. (1993). Expectations, performance evaluation, and consumers' perceptions of quality. *Journal of marketing*, 57(4), 18-34.
- [83] Tse, D. K. and Wilton, P. C. (1988). Models of consumer satisfaction formation: An extension. *Journal of marketing research*, 25(2), 204-212.
- [84] Van Riel, A. C. R., Liljander, V. and Jurriens, P. (2001). Exploring consumer evaluations of e-services: a portal site. *International journal of service industry management*, 12(4), 359-377.
- [85] Visentini, M. S. and Fenner, V. U. (2017). Lealdade: análise da produção científica brasileira na área de marketing no período compreendido entre 2010 e 2016. *Perspectivas em Gestão & Conhecimento*, 7(2), 175-198.
- [86] Wang, R. and Tseng, M. (2011). Evaluation of international student satisfaction using fuzzy importance-performance analysis. *Procedia-Social and Behavioral Sciences*, 25, 438-446.
- [87] Westbrook, R. A. and Oliver, R. L. (1991). The dimensionality of consumption emotion patterns and consumer satisfaction. *Journal of consumer research*, 18(1), 84-91.
- [88] Wolter, J. S., Bock, D., Smith, J. S. and Cronin Jr., J. J. (2017). Creating ultimate customer loyalty through loyalty conviction and customer-company identification. *Journal of Retailing*, 93(4), 458-476.
- [89] Yi, Y. (1990). A critical review of consumer satisfaction. *Review of marketing*, 4(1), 68-123.
- [90] _____. (1993). The determinants of consumer satisfaction: the moderating role of ambiguity. *ACR North American Advances*.
- [91] Yu, Y. T. and Dean, A. (2001). The contribution of emotional satisfaction to consumer loyalty. *International journal of service industry management*, 12(3), 234-250.
- [92] Zeithaml, V. A., Berry, L. L. and Parasuraman, A. (1993). The nature and determinants of customer expectations of service. *Journal of the academy of Marketing Science*, 21(1), 1-12.
- [93] _____. (1996). The behavioural consequences of service quality. *Journal of Marketing*, 60(2), 31-46.

Relationship between obstructive sleep Apnea Syndrome and Anthropometric Measures

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Abstract— Anthropometric measures characterized by body mass index and waist and neck circumferences, are considered strong predictors of sleep disorders. Thus, the objective of this research was to evaluate the relationship between anthropometric data and sleep disorder in adults and elderly individuals. The research was carried out with patients attending at a Cardiology Clinic in a city in the interior of the center-west of São Paulo. In addition to personal identification data, anthropometric measures of weight, height, waist (CC) and neck circumferences (NC) and body mass index (BMI) were calculated. The occurrence of sleep disturbance was assessed under the aspect of the risk of occurrence of obstructive sleep apnea (OSA) using the STOP-Bang questionnaire. The study was approved by the Research Ethics Committee of the University of Marília - Unimar. Adult and elderly patients (n=197) participated in the study, 47% of them male. The mean age of participants was 59.52 ± 13.41 years. With regard to the risk of OSA, 50% of the participants presented intermediate risk, whereas 22% and 28% were classified as low and high risk, respectively, and such risk was significantly related to the anthropometric measures. The Mean Confidence Interval (95%) indicated that BMI, CC and NC values greater than 26.3 kg / m², 90.4 cm and 26.3 cm, respectively, carry a risk of OSA. In conclusion, in view of the results found, more research is needed to improve the understanding of the determinants of sleep disorders in order to prevent or improve the diagnosis and treatment of these conditions.

Keywords— Anthropometry. Sleep apnea. STOP-Bang questionnaire.

I. INTRODUCTION

Modern societies have achieved more benefits and comfort for everyday life, but these advantages have led to profound modifications in the way of life. The consequence was a rapid transition between the effort to search for food (and consequent energy expenditure) by the purchase of industrialized products that generally contain high levels of sugar and fat. Allied to this, there was also a reduction in the practice of physical activity, facts that led to the increase of overweight and obesity worldwide (BARBALHO et al., 2015; SADEGUI et al., 2016; BEMMOHAMMED et al., 2016).

These lifestyle changes have an impact on the incidence of metabolic disorders such as the development of type 2 diabetes, dyslipidemias, systemic arterial hypertension (HAS), and metabolic syndrome (MS) that aggravate the risk of developing cardiovascular disease (CVD), which are the most common chronic-degenerative diseases related to mortality (SALTIEL et al., 2017;

CALABUIG et al., 2016; ZAHID et al., 2016; FURUHASHI et al., 2015)

Anthropometric measures that mark overweight (overweight or obese), including body mass index and waist and neck circumferences, are considered to be strongly related to the occurrence of sleep disorders (CARTER and WATTENPAUGH, 2008). Sleep is one of the natural functions of the living being controlled by the biological clock. The occurrence of sleep disorders plays a significant role in the aetiology of diseases associated with MS, such as obesity, diabetes and hypertension (SPIEGEL et al., 2004). In addition, studies have shown that poor sleep quality, especially in combination with increased visceral adiposity, is strongly linked to the development of a chronic, low-intensity inflammatory state leading to the release of cytokines and chemokines, including interleukin-1 beta (IL-1 β), tumor necrosis factor alpha (TNF- α) and IL-6, as well as hs-CRP and cortisol, factors that contribute to the aggravation of numerous metabolic complications (HUANG et al., 2017;

PRATHER et al., 2014; LIU et al., 2014; OPP, 2005; PRINZ et al., 2000).

These findings led to the objective of this research to evaluate the relationship between anthropometric data and sleep disorder in adults and elderly individuals.

II. METHODS

This is an exploratory, analytical, primary and observational, cross-sectional, single center study. The research was carried out with patients attending a Cardiology Clinic in a city in the interior of the center-west of São Paulo.

Patients were invited to participate in the study receiving clarification on the research protocol and those who accepted confirmed the acceptance by signing the informed consent form.

In addition to the personal identification data (name, sex and age), information was collected on the level of schooling, previous diagnosis of diseases or clinical conditions, use of medication on a continuous basis, presence of smoking, consumption of alcoholic beverages and practice of physical activity.

The anthropometric measurements were weight and height, from which the body mass index (BMI) was calculated. The waist (WC) and neck circumferences (NC) were also collected. For the collection of weight, stature and WC we used techniques recommended by Lohman et al. (1988) and Gibson (2005). The BMI was calculated according to Quetelet's formula (COLE et al., 1981). NC was measured at the mean neck height and in men just below the laryngeal prominence (BEN-NOUN; LAOR, 2003). NC was classified according to Ben-Noun et al. (2001), which values less than 34 cm and 37 cm are considered in normality for women and men, respectively.

The occurrence of sleep disturbance was assessed in terms of the risk of occurrence of obstructive

sleep apnea (OSA) using the STOP-Bang (Snoring, Tiredness, Observed Apnea, and High Blood Pressure - Body mass index, Age, Neck Circumference, and Gender) consisting of eight issues relating to snoring, fatigue / fatigue / drowsiness, and apnea observed during sleep, blood pressure, BMI, age, NC, and gender. Questions can be answered affirmatively by a point or negatively by zero point, and the final score of this instrument can range from zero to 8 points. Summation between zero and two points indicates low risk of OSA, while three to four points indicates intermediate risk and five to eight points high risk (FONSECA et al., 2016).

The statistical treatment of the quantitative data was performed with the support of the BioEstat 5.0 program. The data were presented by means of relative frequency and the descriptive statistics in table presenting the mean \pm standard deviation, median and minimum and maximum values. In order to evaluate the significance of the relationship between the studied variables, Student's t-tests, Anova followed by Tukey, Kruskal-Wallis followed by Dunn, and Pearson's correlation tests and the mean confidence interval (Bootstrap Resampling Technique) were used. The tests were selected according to the purpose of the analysis and the variance of the data to be analyzed. The probability of significance considered was 5% ($p \leq 0.05$) for the operations performed.

This study was approved by the Research Ethics Committee of the University of Marília - Unimar under protocol number 1,989,745.

III. RESULTS AND DISCUSSION

A total of 197 adult and elderly patients were included in this study, 47% of them male. The mean age of participants was 59.52 ± 13.41 years, with no significant difference between the two sexes ($p = 0.4329$).

The anthropometric measures evaluated are presented in Table 1.

Table.1: Descriptive presentation of age and anthropometric measures evaluated.

Parameters	Mean \pm standard deviation	Median	Minimum	Maximum
Age (years)	59.52 \pm 13.41	61	25	89
BMI (kg/m ²)	28.85 \pm 5.58	28	18	58
WC (cm)	100.15 \pm 14.3	100	59	139
NC (cm)	38.32 \pm 4.24	38	29	52

BMI: body mass index. WC: waist circumference. NC: circumference of the neck.

The application of the STOP-Bang questionnaire resulted in an average score of 3.63 ± 1.56 (minimum-maximum = 0-8). With regard to OSA risk, 50% of the participants presented intermediate risk, while 22% and 28% were classified as low and high risk, respectively.

A significant relationship was found between the risk of OSA and the anthropometric measures analyzed in this study. The higher the BMI, WC and CP, the higher the risk (Table 2).

Table.2: Anthropometric measures (BMI, WC and NC) according to the risk of obstructive sleep apnea (OSA).

Risk of OAS	Measure	BMI (kg/m ²)	WC (cm)	NC (cm)
Low (n=44)	Mean±standard deviation	27.45±3.88 ^A	93.61±10.91 ^A	36.45±3.91 ^A
	CI of the mean (95%)	26.3 - 28.4	90.4 – 96.3	35.3 – 37.4
Intermediary (n=99)	Mean±standard deviation	28.20±5.42 ^A	98.09±13.12 ^A	37.78±3.61 ^A
	CI of the mean (95%)	27.2 – 29.1	95.5 – 100.2	37.1 – 38.4
High (n=54)	Mean±standard deviation	31.20±6.37 ^B	109.25±14.62 ^B	40.85±4.47 ^B
	CI of the mean (95%)	29.6 – 32.6	105.5 – 112.5	39.6 – 41.8
	p-value	0.0037*	0.0000**	0.0000**

CI: Confidence interval. BMI: body mass index. WC: waist circumference. NC: circumference of the neck. ns: non significant. *Kruskal-Wallis / Dunn. **Anova one way / Tykey. Means followed by the same capital letter in the columns do not differ from each other by the statistical test at 5% probability.

The Confidence Interval (CI) of Mean (95%) allows us to infer that BMI values above 26.3 kg / m² entail risk, at different levels, of OSA. The same reasoning is possible for WC and NC measurements, whose risk-related values are 90.4 cm and 35.3 cm, respectively.

In our study, 50% of the patients presented intermediate risk and 28% high risk of OSA. These values are superior to those found in other studies using the same instrument, the STOP-Bang.

Bamgbade et al. (2017) in a study with women undergoing abdominal surgery showed 18.1% and 11.3% had intermediate and high risk of OSA, respectively.

Dixon et al. (2016) evaluated 1635 patients from a surgical hospital and found that 14.89% had intermediate risk of OSA and only 3.93% were at high risk.

Patients from a hospital in Nigeria were evaluated by Ozoh et al. (2014). These authors found that the risk of OSA was 36.3% of patients at high risk.

Obesity was positively associated with the risk of OSA in our study as well as in others, such as that of Ozoh et al. (2014), from Bamgdage et al. (2017), from Dixon et al. (2016), de Ruiz et al. (2016) and Kiełbasa et al. (2016).

Dixon et al. (2016), Bamgdage et al. (2017) observaram que a CP aumentada (> 40 cm) leva a maior risco de AOS. Ruiz et al. (2016) observaram correlação positiva entre CP e risco de AOS.

Dobrosielski et al. (2016) and Soler et al. (2017), as well as in this study, found that the higher the CP measure, the greater the risk of OSA.

The occurrence of OSA is a common condition among patients treated at the aforementioned Cardiology Clinic, with percentages higher than that of other

populations. Although the instrument used to assess such a disorder is widely known, its performance may vary among populations.

IV. CONCLUSION

The IMC, WC and NC are anthropometric measures that presented a positive and significant relationship with the occurrence of sleep disorders, since the increase of these measures led to an increased risk of OSA.

We suggest that further research is necessary to improve the understanding of the determinants of sleep disorders in order to provide prevention or even improve the diagnosis and treatment of these conditions.

REFERENCES

- [1] BAMGBADE, O.A. et al. Obstructive sleep apnea and postoperative complications among patients undergoing gynecologic oncology surgery. *Int J Gynaecol Obstet.*, v. 138, n. 1, p. 69-73, 2017.
- [2] BARBALHO, S.M. et al. Metabolic Syndrome, Atherosclerosis and inflammation: inseparable triad? *J Vasc Bras.*, v.14, n.4, p.319-326, 2015.
- [3] BENMOHAMMED, K. et al. Metabolic syndrome in adolescents: definition based on regression of IDF adult cut-off points. *Public Health.*, v.141, p 88-94, 2016.
- [4] BEN-NOUN, L.; LAOR, A. Relationship of neck circumference to cardiovascular risk factors. *Obes Res.*, v.11, p.226-31, 2003.
- [5] CALABUIG, Á. et al. Epicardial Adipose Tissue in the General Middle-aged Population and Its Association With Metabolic Syndrome. *Rev Esp Cardiol (Engl Ed)*, nov. 2016.
- [6] CARTER, R.; WATENPAUGH, D.E. Obesity and obstructive sleep apnea: or is it OSA and obesity? *Pathophysiology*, v. 15, n. 2, p.71-7, 2008.

- [7] COLE, T.J.; DONNET, M.L.; STANFIELD, J.P. Weight-for-height indices to assess nutritional status - a new index on a slide-rule. *Am J Clin Nutr.*, v.34, n.9, p.1935- 1943, Sep., 1981.
- [8] DIXON, S.E. et al. Quality Improvement Project: Using the STOP-BANG Tool in a Military Population to Improve Equity in Preoperative Screening. *J Perianesth Nurs.*, v. 31, n. 5, p. 371-80, 2016.
- [9] DOBROSIELSKI, D.A. et al. Estimating the Prevalence of Sleep-Disordered Breathing Among Collegiate Football Players. *Respir Care.*, v. 61, n. 9, p. 1144-50. 2016.
- [10] FONSECA, L.B.M. et al. STOP-Bang questionnaire: translation to Portuguese and cross-cultural adaptation for use in Brazil. *J Bras Pneumol.*, v.42, n.4, p.266-72, 2016.
- [11] FURUHASHI, M. et al. Fatty acid binding protein 4 (FABP4): Pathophysiological insights and potent clinical biomarker of metabolic and cardiovascular diseases. *Clin Med Insights Cardiol.*, v. 8 (Suppl 3), p.23-33, 2015.
- [12] GIBSON, R.S. Principles of nutritional assessment. 2^o Edition, Oxford University Press, 2005.
- [13] HUANG W.Y. et al. Associations of Self-Reported Sleep Quality with Circulating Interferon Gamma-Inducible Protein 10, Interleukin 6, and High-Sensitivity C-Reactive Protein in Healthy Menopausal Women. *PLoS One.*;v.12, n.1, 2017.
- [14] JAMKA, M. et al. The effect of vitamin D supplementation on insulin and glucose metabolism in overweight and obese individuals: systematic review with meta-analysis. *Sci Rep.*; v.5, 16142, 2015.
- [15] KIELBASA, G. et al. Assessment of sleep disorders among patients with hypertension and coexisting metabolic syndrome. *Adv Med Sci.*, v. 61, n. 2, p. 261-68, 2016.
- [16] LIU, R. et al. Association between sleep quality and C-reactive protein: results from national health and nutrition examination survey, 2005–2008. *PLoS One.*; v.9, n.3, e92607, 2014.
- [17] LOHMAN, T.G.; ROCHE, A.F.; MARTORELL, R. Anthropometric standardization reference manual. Abridged Edition, 1988.
- [18] OPP, M.R. Cytokines and sleep. *Sleep Med Rev.*; v.9, n.5, p.355–64, 2005.
- [19] OZOH, O.B. et al. Prospective assessment of the risk of obstructive sleep apnea in patients attending a tertiary health facility in Sub-Saharan Africa. *The Pan African Medical Journal.*, v. 17, n. 302, p. 1-7, 2014.
- [20] PRATHER, A.A. et al. Poor sleep quality potentiates stress-induced cytokine reactivity in postmenopausal women with high visceral abdominal adiposity. *Brain Behav Immun.*; v.35, p.155–62, 2014.
- [21] PRINZ P.N.; BAILEY S.L.; WOODS D.L. Sleep impairments in healthy seniors: roles of stress, cortisol, and interleukin-1 beta. *Chronobiol Int.*; v.17, n.3, p.391–404, 2000.
- [22] RUIZ, A.J. et al. The associations between sleep disorders and anthropometric measures in adults from three Colombian cities at different altitudes. *Maturitas*, v. 94, p. 1-10, 2016
- [23] SADEGHI, M. et al. Assessing Metabolic Syndrome Through Increased Heart Rate During Exercise. *Acta Med Iran.*; v.54, n.11, p.724-730, 2016.
- [24] SALTIEL, A.R.; OLEFSKY, J.M. Inflammatory mechanisms linking obesity and metabolic disease. *J Clin Invest.*, v.127, n.1, p.1-4, 2017.
- [25] SOLER, X. et al. Age, gender, neck circumference, and Epworth sleepiness scale do not predict obstructive sleep apnea (OSA) in moderate to severe chronic obstructive pulmonary disease (COPD): The challenge to predict OSA in advanced COPD. *PLoS One.*, v. 16, n. 5, p. 1-12, 2017.
- [26] SPIEGEL, K. et al. Brief communication: Sleep curtailment in healthy young men is associated with increased leptin levels, elevated ghrelin levels, and increased hunger and appetite. *Ann Intern Med.*, v. 141, n. 11, p. 846-50, 2004.
- [27] ZAHID H.; SIMPSON E.R.; BROWN K.A. Inflammation, dysregulated metabolism and aromatase in obesity and breast cancer. *Curr Opin Pharmacol.*; v.31, p.90-96, 2016.

HidroSmart: Water Control and Preservation System

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Abstract—The HydroSmart consists of a system of control and quantification of rainwater, focused on the economy and awareness of water resources, minimizing the withdrawal of the same from the sources and distributors. The system is controlled through a microcontroller programmed to send commands to the water network of a residence. At the same time, the system will send information to a Smartphone via bluetooth. The article will show the step-by-step construction of the HydroSmart prototype to test the feasibility of the system. Thus, with the use of the application the user can access the water consumption. The good performance of the system and the application is an excellent tool that uses the technology to preserve the environment.

Keywords—Arduino Uno, Water Control.

I. INTRODUCTION

The change in the rainfall regime on the planet caused by global climate change [1] has also influenced the precipitation regime in Brazil, which could be evidenced by the supply crises in the cities of São Paulo and Minas Gerais in Brazil, in the years of 2014 and 2015 [2]. The supply crisis in the states of the southeastern region of Brazil has caused impacts in several sectors of society such as agriculture, industry and electric energy [3].

The 2015 drought was so severe that it left several cities in the southeastern region without water for days or even weeks, which led the population to seek sustainable alternatives to water use. In order to raise awareness, reduce costs and preserve the environment, technologies for the sustainable use of water have been developed, such as rainwater harvesting in homes and public buildings, reuse of water from air conditioners and household appliances such as washing machines and other.

Although the Amazon region has high rainfall levels, reaching 900 mm during the transition months [4], climate change has also affected rainfall in the region, such as the 2005 drought that caused several rivers to dry up causing death of several aquatic species. On the other hand, the occurrence of torrential rainfall in large cities and the soil sealing process is a consequence of urbanization, which prevents rainwater from infiltrating, increasing surface runoff and causing flooding areas, urban

drainage problems, and at the same time decreasing groundwater reserves [5], showing the other face of climate change. These extreme events, followed by events of long periods of drought and water shortages, lead society to think of sustainable ways to use water resources, such as rainwater harvesting.

The technology is a strong ally of sustainable practices, having as one of the main tools automation systems [6][7] and applications for mobile phones [8]. Thinking about this problem, this work will show an option of rainwater control and preservation system, called *HidroSmart*.

HidroSmart is an interactive system that adds rainwater harvesting, controlling and directing the consumption of water in a residence through the use of a Smartphones application, through which we will try to reduce the waste of water in the residence. In addition, the system still quantifies and shows in a simple way how the user can reduce their daily water consumption, reducing thus, the costs of the water bill and in parallel, reinforce for the population a more sustainable awareness. Through the installation of *HidroSmart* in any Smartphone the application will show the consumption of water to the day, month and even the year inside a residence, as it will reuse the rainwater, preserving and guaranteeing the preservation of the water sources.

Thus, this paper will show in section II the construction of the methodology, the materials used during the construction of the prototype and the tests performed with it, and finally in section III we will show the results achieved during the tests with the prototype, in addition to the expected results in one single family residential system, and finally section IV will show a summary of the most significant results presented by the *HidroSmart* system.

II. MATERIAL AND METHODS

The modeling, development, construction and testing of the *HydroSmart* prototype were carried out during the period from August to October 2018, at the premises of Universidade Paulista - UNIP. The steps that will be described next: II.1, will be shown some of the materials used in the construction of the prototype, while in II.2 a description of the hydraulic system of the *HydroSmart* will be carried out, being this separated into: network 1, which shows the path of the water coming from the concessionaire and the network 2: rainwater. In addition, section II.3 will show the structure of the *HidroSmart* application, which counts the general water consumption of the residence.

3.1 MATERIAL

The system was designed with the proposal of being simple and low cost, so that it can be implemented in single family homes in the future. By implementing the *HydroSmart* you can achieve great savings on the water bill of the residence in which the system was installed. With this in mind, we tried to use the materials available in the market which we tried to associate with characteristics such as durability, quality and low cost. Therefore, Table 1 shows the list of materials used in the construction of the *HydroSmart* prototype and its respective cost in Manaus during the second half of 2018 (updated value with the value of the dollar on 09/05/2019).

3.2 METHODOLOGY

The hydraulic project consists of two water supply networks (Figure 1), one in which the water source is the utility responsible for the distribution of water in the city, and a second, where the source of the water is the rainwater captured, both controlled by a system of Arduino circuit, which counts the water consumed by the two networks will send to a SmartPhone application.

Table 1: Bill of materials used to build the *HydroSmart* prototype, and costs

Material	Quantity
Pipe of ½	1
Plywood	1
Clamp	10
Water Tank of the 5 L	2
Water Tank of the 10 L	2
Arduino	1
FlowSensor	1
Relé Module 5V of the 2 Channels	1
Waterlevel sensor	2
Bluetooth Module	1
SolenoidFlowValve	2
Power Supply of the 12V	1
Box Adapter	7
Power Supply of the 9V	1
WaterTap	3
White Pipe of the 50 mm	1
Total Cost of Materials	\$ 6.494,76

Source: Authors, (2019).

3.2.1 NETWORK – 1

The hydraulic network of the utility will supply the water that will pass through a solenoid valve and will be at the entrance of the water tank. In this way, the valve will be connected to a flow sensor that will be installed inside the water box which can open or close the water supply system, as well as verify the water consumption. Also, this valve will control the water level, not allowing this overflow, at the same time, through this control will never lack water from the utility in the reservoir of the residence. So that the water of the concessionaire does not lack, in the exit of the box of water will be installed a sensor of flow that will make the reading of passage of the fluid through electrical pulses, thus sending the information to an Arduino Mega circuit.

The electronic prototyping platform used is a single, free board hardware, with 54 pins of digital inputs and outputs, 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a power input, a USB connection and an ICSP connection [6]. Its programming is carried out through C++ Software which is responsible for performing the calculations of the passage of water in days, weeks and even months and years. The water used by the system can be used for washing and preparing food and washing clothes and at the end of this system has a flow

valve that will be closed and will only open in the absence of water in the rainwater catchment tank.

3.2.2 NETWORK – 2

Network-2 is the rainwater collected through a gutter installed on the roof of the residence directing all the water collected to a reservoir, where an extravasor installed in the reservoir does not allow the water to overflow. At the same time, a level float will also be

installed in the rainwater reservoir. When the rainwater tank is too low and the remaining fluid can not be used, there will be a flow transfer to Network-1 (water from the utility). Thus, the water will pass through the flow sensor that will count the consumption being controlled by a mobile application. The transport of the water to the reservoir is carried out by means of a hydraulic pump of 127 Volts.

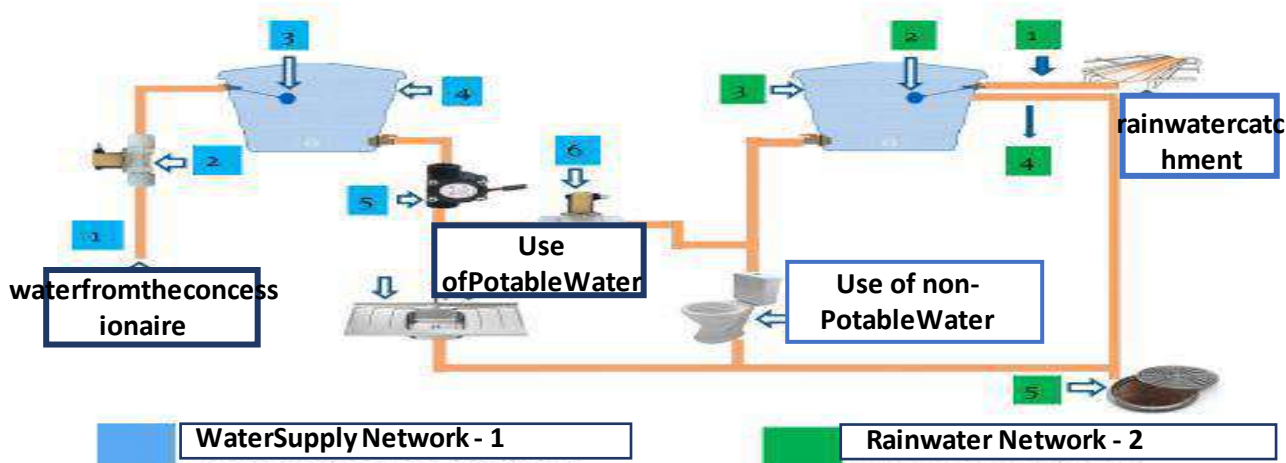


Fig.1: Project Diagram.

Source: Authors, (2019).

Table 2: Label of the Network-1 and Network -2

Network 1 – Concessionaire		Network 2 - Rainwater Harvesting	
1	PVC Pipe of the ½	1	Pipe of the ½
2	Solenoid Flow Valve	2	Water level sensor
3	Water level sensor	3	Water Tank of the 10 L
4	Water Tank of the 10 L	4	Extravasor
5	Flow Sensor	5	Sewer
6	Solenoid Flow Valve		

Source: Authors, (2019).

Table 3: Legend of the Components.

Components	
1	Power Supply of the 9V
2	Relé Module 5V of the 2 Channels
3	Solenoid Flow Valve
4	Solenoid Flow Valve
5	Water level sensor
6	Bluetooth Module
7	Arduino
8	Flow Sensor
9	Water level sensor

Source: Authors, (2019).

Interconnection of networks – Networks 1 and 2 will be interconnected through a solenoid valve that will always be closed, but at the same time, the communication of each Network and the interaction between them is controlled by a level sensor installed in the rainwater box lack of water in the reservoir.

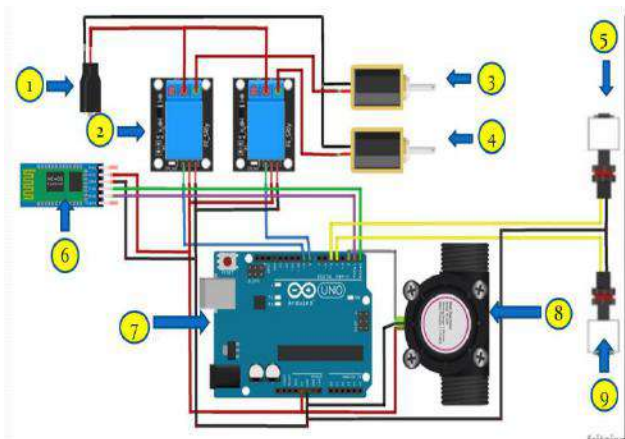


Fig.2: HidroSmart electric scheme.

Source: Authors, (2019).

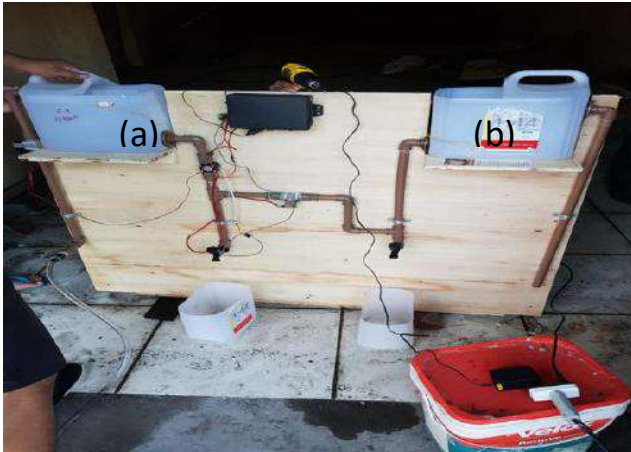


Fig.3: Prototype Assembly. a) Network-1; Simulation of the water reservoir from the concessionaire; b) Network-2; Simulation of the rainwater reservoir.

Source: Authors, (2019).

3.2.3 ROBOREMOFREE

The daily / monthly / annual consumption of water by the user is controlled through a remote-control application (Figure 4), used in Arduino-based projects. Robotooth is a 100% free platform, with no ads or user information collection, at the same time, is limited to 5 items per interface (not counting the menu button, text fields and touch stoppers).

The plots of the can display the real-time data of the sensors, and can be connected to the Arduino board directly through the OTG cable (if the device supports OTG), or use a wireless module which can connect through Bluetooth (Bluetooth SPP -BlueSMIRF, HC-05, HC-06, BTM-222, etc., and / or bluetooth low energy BLE - CC2540, CC2541, etc.) or Wii-Fi.

RoboRemoFree allows real-time control of the flow of water passing through the sensor identified by position "6" in Figure 3, which are converted into the application screen in liters via Bluetooth.

Use plots to display real-time data from sensors, which can be connected to the Arduino board directly using the OTG cable (if the device supports OTG), or the wireless module can be used and connect over Bluetooth or WiFi [10].

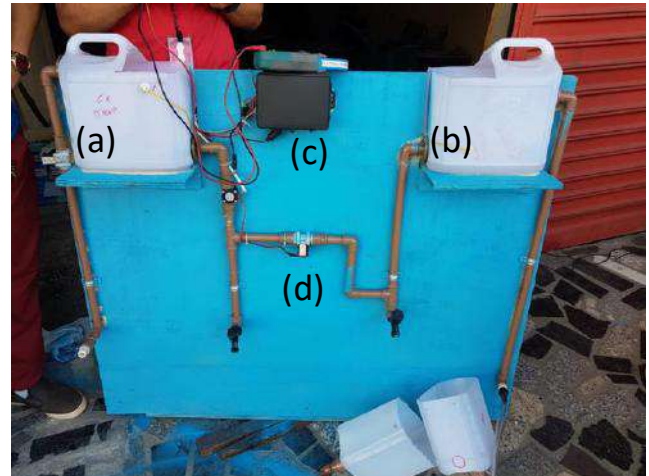


Fig. 6: Prototype. a) Network-1 - Simulation of the water reservoir from the concessionaire; b) Network-2 - Simulation of the rainwater catchment; c) Arduino system; d) control valve.

Source: Authors, (2019).

III. RESULTS

The tests with the prototype were performed in two stages. At first, only the hydraulic system was tested, verifying the incoming and outgoing flows of water from the utility (Figure 5a) and the reservoir (Figure 5b). Once the efficiency of the interaction between the two networks (utility flow and rainwater flow) was confirmed, the Arduino system was implemented, thus showing the first reports of water consumption sent to the application (Figure 7a). Each water outlet was tested separately (Figure 7b).

Through the flow valve it was possible to account for the water consumption of the two reservoirs. The information of the total water consumed in liters/minutes is sent via Bluetooth to the user's smartphone. The losses of water have a direct relation with the energy consumption, thus it was necessary about 0.6 kWh for the use 1m³ of drinking water. This shows that both hydraulic and energy efficiency are key to the proper management of water supply systems.

Figure 7a shows the result of the real-time estimate displayed on the Smartphone screen, in liters per minute of water consumption. Note that when it shows buoy 1 on the screen, it indicates that the valve is releasing the passage of the waters coming from the concessionaire. On the other hand, when this system is deactivated the information that will appear on the screen will be referred to float 2. In Figure 7a, float 1 is activated, releasing the water passage showing a consumption estimate of 2.55 L/min, and subsequently 2.36 L/min.

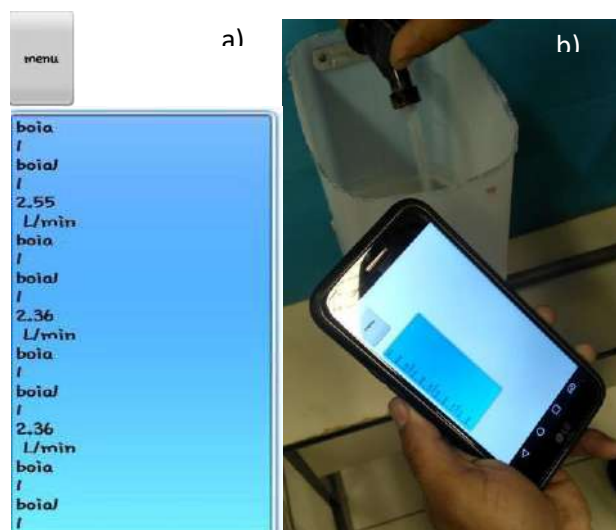


Fig. 7: a) Main screen showing water consumption (liters/min); b) Validation test of water consumption and measured by APP.

Source: Authors, (2019).

Because of the pollutants released daily into the atmosphere, it is not possible to use rainwater for potable purposes, so water collected and stored on Network-2 and used by HydroSmart will be for non-potable purposes only, such as a toilet (6 liters in each use), car wash (average 216 liters in each wash), sidewalk washing (279 liters), gardening (250 liters). Although tests with the HydroSmart prototype showed excellent results and an apparent economy, it was not installed in a residence.

IV. CONCLUSION

During the last decades, society has become aware of the importance of the conscious use of drinking water present in rivers, lakes and even in our homes. The last two droughts in the southeastern and northern regions of the country led the big cities to think about alternative ways of preserving and collecting rainwater. In addition, the latter events require increased attention, showing a strong concern about the waste and the costs of these charged by the concessionaires. Thinking of ways to minimize wastage and sustainable forms that has created HidroSmart.

Using materials that are easy to access and purchase for any user, the system has been constructed in a way that does not modify the characteristics of the original hydraulic system of the residence. The system uses two Networks; Net-1, a potable water flow system, which uses only water from the utility; and the Net-2 rainwater system, used only in toilets, car washes and outside areas of the residence and gardening. The opening and closing of

the water flow of the networks performed through a valve controlled by an Arduino system.

The flow and water consumption of the two Networks are monitored via Smartphone. RoboRemoFree is a public domain application, free and easy to access to any user. The application is the way in which the Arduino sends the user his or her water consumption every minute. Sending the lit / min information is performed every 60 seconds on the Smartphone screen. At the same time, this information will be stored and made available at the end of each month showing the user the water consumption of the utility.

The project is a way to improve water consumption in homes, leaving portions of pipelines programmed to make distributions in strategic locations and receive rainwater, not only having the primary function of combating water waste, but also generating savings in invoices from water utilities.

Through this tool the user can request information about the water consumption of his residence 24 hours a day, so he can change his habits in situations of water rationing.

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REFERENCES

- [1] Marengo JÁ. Water and Climate Change. *Advanced Studies* 22 (63): 83-95, 2008.
- [2] Coelho, C.A.S., Cardoso, D. H. F. & Firpo, M.A. F. (2016). The drought of 2013 to 2015 in the southeastern region of Brazil. *Climanálise - Special Edition of 30 years*, p. 55-61.
- [3] Jacobi, P. R., Cibim, J., Leão, R. S. Water crisis in the Macrometropole Paulista and civil society responses. *Advanced Studies*. 29 (84), 2015.
- [4] Ficsch, G., Marengo, J. A., Nobre, C. A. A general review of the Amazonian climate. *Acta Amazonica* 28 (2), 101-126, 1998.
- [5] Tucci, Carlos E. M. *Hydrology: Science and Application*. 4th edition. Porto Alegre, publisher of UFRGS, 2013.
- [6] Trojan, F., Kovaleski, J. L. *Automation in water supply: A tool to reduce losses and improve working conditions*. XII SIMPEP, Bauru, SP, 2005.
- [7] What do you think? *Automation in basic sanitation: different needs for the same objective*. *Revista Controle & Instrumentação*, ed. 61, São Paulo, SP, 2001.
- [8] Araújo, M., Cerqueira, M. A., M., Silva, A. B. L., Barbosa, C. L. M., Cordeiro, R. M. *Droplless App - Sustainable Use of Water Through Smartphones*. XXII Expocom 2015 Award, in the Communication and Innovation category. 2015. Available

<http://www.portalintercom.org.br/anais/nordeste2015/expo-com/EX47-2619-1.pdf>

- [9] Silva, A.D.C., Rocha, LV., Machado, A.P., Gutierrez, D.M.G., Santos, L.S., Gutierrez, C.B.B. Automation system for rainwater harvesting and residential water management using mobile application. Spaces. v 38 (2), 101-126, 2017.
- [10] Gonçalves, R. A. S. Web Development using Web Standards and Technologies. Degree in Systems Engineering and Informatics, Jean Piaget University of Cape Verde, Praia City, January 05, 2010.

Discomalleolar Ligament: A Review with a clinical Approach

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Abstract— *The discomalleolar ligament is described as a fibrous connection that anatomically and functionally relates the malleus bone in the middle ear to the posteromedial portion of the joint capsule through the petrotympanic fissure. It is a structure that presents important clinical aspects, since it may be related to otologic symptoms in temporomandibular joint dysfunctions. The objective of the present study was to perform a systematic review of the presence of the discomalleolar ligament, its possible influences on otologic symptoms and correlation with temporomandibular dysfunction. The analyzed sources of the literature review were searched in PubMed, Scielo, Web of Science, Lilacs, Google Scholar and Ebsco databases through a combination of keywords. An analysis of anatomical specimens was performed through the inspection of 277 adult skulls and 9 infant skulls, in order to verify the presence of foramina in the petrotympanic fissure on both sides. A computed tomography image was included in this study and showed a hypodense circular structure suggestive of foramen and possible passage of this ligament towards the disc of the temporomandibular joint. The evaluation of the anatomical parts showed that the adult skulls analyzed, about 90% had a foramen on both sides, 1.44% on the right side only, 4.33% on the left side only and 3.61% did not present foramen in any of the sides. About the children's skulls, 33.3% had a foramen on both sides, 33.3% on the right side and 33.3% had no foramen on either side. In results, the methods evaluated and the studies analyzed show the anatomical relationship between the tympanic cavity and*

temporomandibular joint, as well as the existence of the discomalleolar ligament and its possible influence on the otologic symptoms caused by temporomandibular disorders.

Keywords— *Temporomandibular joint, Malleus, Middle ear, Temporomandibular joint disorders.*

I. INTRODUCTION

The stomatognathic system is closely related anatomically and ontologically to the region surrounding the middle ear structures (RAMÍREZ ARISTEGUIETA, BALLESTEROS ACUÑA, & SANDOVAL ORTIZ, 2009)(RODRÍGUEZ VÁZQUEZ, J, MERÍDA VELASCO, J, & JIMÉNEZ COLLADO, 1993). The discomalleolar ligament is one of the fibrous connections that relates the malleus to the posteromedial portion of the temporomandibular joint capsule (PINTO, 1962), is also described as a triangular-shaped band of connective tissue whose base is continuous with the posterior region of the joint capsule and disc, which is directed to the middle ear through the petrotympanic fissure (COLEMAN, 1970).

Little mentioned in the anatomy books (MORGAN, 1982)(BOCHENEK & REICHER, 1997)(STANDRING, 2005)(ALVES & DEANA, 2010), the discomalleolar ligament was first referred to in 1954 (REES, 1954), but its detailed description was performed in 1962 and is also described and demonstrated by several other authors (PINTO, 1962). It is a structure that penetrates the caudal end of Meckel's cartilage corresponding to an embryological remnant of the lateral pterygoid muscle (CHEYNET, GUYOT, RICHARD,

LAYOUN, & GOLA, 2003). However, other researchers stated that Meckel's cartilage has no influence on the development of the temporomandibular joint and also that during the embryonic stage there is no evidence that the lateral pterygoid muscle attaches to the malleus (FURSTMAN, 1963)(YUODELIS, 1966).

The discomalleolar ligament is a structure that presents important clinical aspects (ALVES & DEANA, 2010). Some authors state that dysfunctions in the temporomandibular joint (TMD) cause alteration of the discomalleolar ligament, causing a displacement of the malleus, resulting in some symptoms such as tinnitus and deafness (PINTO, 1962)(IOANNIDES & HOOGLAND, 1983). Although the risks of otological symptoms are greater in individuals presenting with disorders such as pain during the opening and closing of the mouth or palpation of the temporomandibular joint (PASCOAL, 2001)(LAM, LAWRENCE, & TENENBAUM, 2001). The origin and possible relations between these structures are not fully understood (FELICIO, FARIA, & DA SILVA, 2004). This structure can usually be observed in dissected anatomical pieces. However, it is also possible to visualize it in concomitant computed tomography in sagittal sections. In the images, furthermore to discomalleolar ligament, structures related to temporomandibular joint are also observed within the petrotympanic fissure. In Cone Beam CT images, the petrotympanic fissure resembles a small lumen that extends in the direction of the epitympanic recess in the upper portion of the tympanic cavity, where inferiorly the malleus bone is located. Studies demonstrate the visualization in tomographic images and anatomical pieces that discomalleolar ligament connects to the head and anterior region of the malleus bone, disposed from the posterior and superior portion of the mandibular fossa, located in the temporal bone (ARAI & SATO, 2012).

Thus, the aim of the present study was to perform a systematic review of the presence of the discomalleolar ligament, its possible influences on otologic symptoms and correlation with temporomandibular dysfunction.

II. MATERIALS AND METHODS

2.1 Computed tomography (CT)

A computed tomography image was used to evaluate the presence of the discomalleolar ligament. The image covers the region of a temporomandibular joint on the left side and was obtained by a scanner I-CAT CT (Cone Beam Volumetric Tomography [I-CATVisionProgram]).

2.2 Anatomical Pieces Evaluation

This stage was based on a careful evaluation of skulls belonging to the Department of Biological Sciences, Anatomy Discipline of School of Dentistry of Bauru- University of São Paulo (FOB-USP). The inspection of the pieces was done with the naked eye and with the aid of a hand magnifier with lighting 75 mm in diameter and increase of 6 times, of the brand Western 3455. It consisted in identifying the presence or absence of foramina in the region of the petrotympanic fissure on the left and right sides of 277 (two hundred and seventy-seven) adult skulls and 9 (nine) children skulls.

2.3 Data source

This literature review contains information available in the databases PubMed, Scielo, Web of Science, Lilacs, Google Scholar and Ebsco, using the following keywords: discomalleolar ligament / discomalleolar ligament, temporomandibular disorders, temporomandibular dysfunction, and petrotympanic fissure. This led to the initiation of a search strategy and articles published between 2006 and 2016 were included, using a keyword search to obtain information about the discomalleolar ligament (figures 1-6).

2.4 Data extraction

After analyzing and reviewing the researched scientific articles, ten relevant studies related to the objectives of the study were found. Several studies resulting from the research were read with the objective of identifying relevant information on the subject in question.

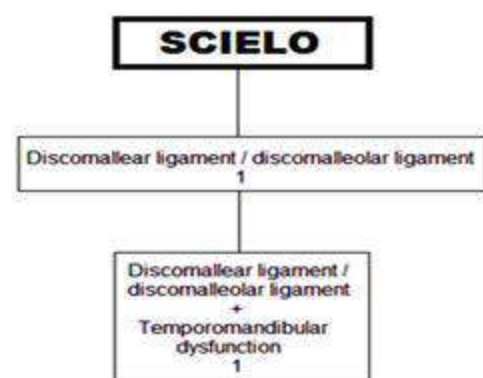


Fig.1: Scielo Keywords combination.

Papers extracted from the Scielo database:

1- Frequency of occurrence of the discomalleolar ligament in the adult man (ALVES; DEANA, 2010).

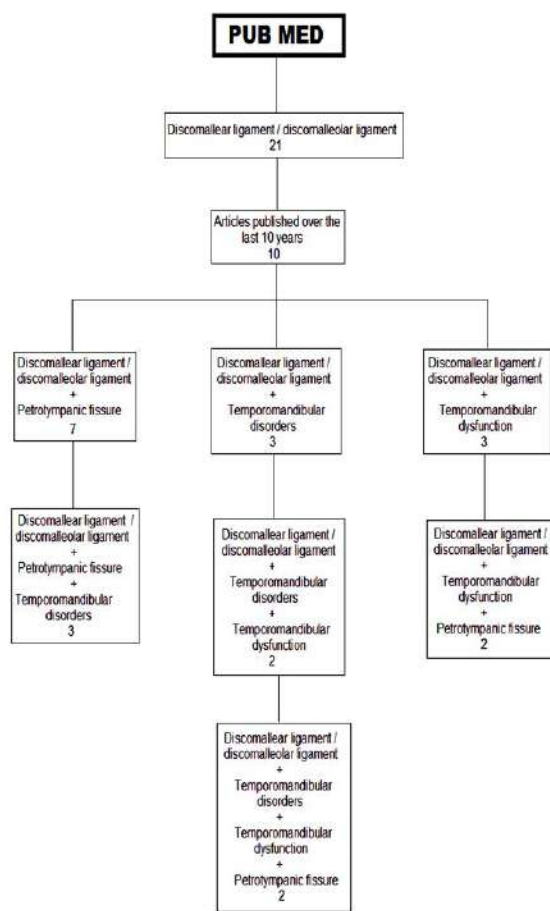


Fig.2: PubMed Keywords combination.

Papers extracted from the PubMed database:

- 1- Prevalence of the types of the petrotympanic fissure in the temporomandibular joint dysfunction (ÇAKUR et al., 2011).
- 2- Classifications of tunnel-like structure of human petrotympanic fissure by cone beam CT (SATO et al., 2008).

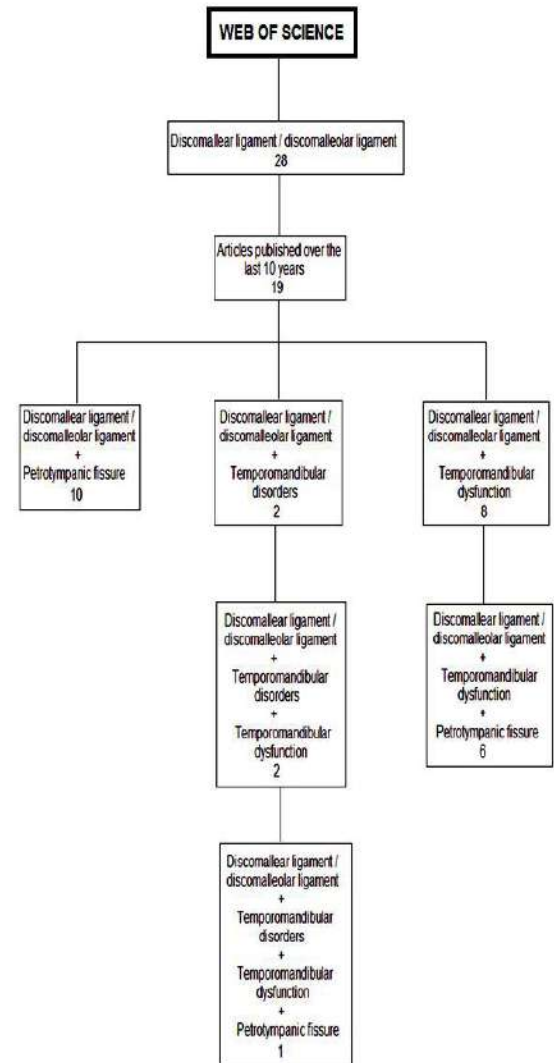


Fig.3: Web of Science Keywords combination.

Papers extracted from the Web of Science database:

- 1- Correlation between tinnitus and petrotympanic fissure status among patients with temporomandibular joint dysfunction (ÇAKUR; YASA, 2016).

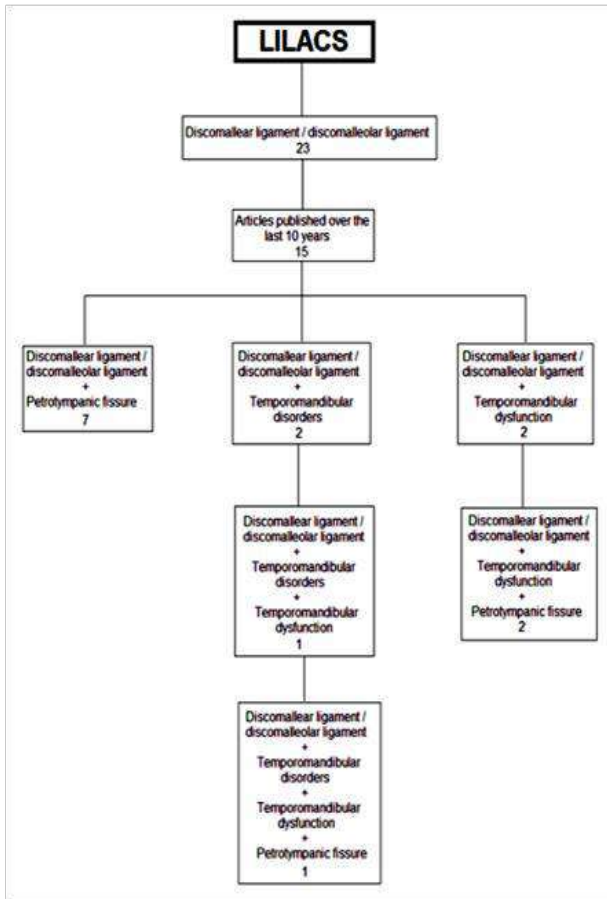


Fig.4: LILACS Keywords combination.

Papers extracted from the LILACS database:

1- Classifications of tunnel-like structure of human petrotympanic fissure by cone beam CT (SATO et al., 2008).

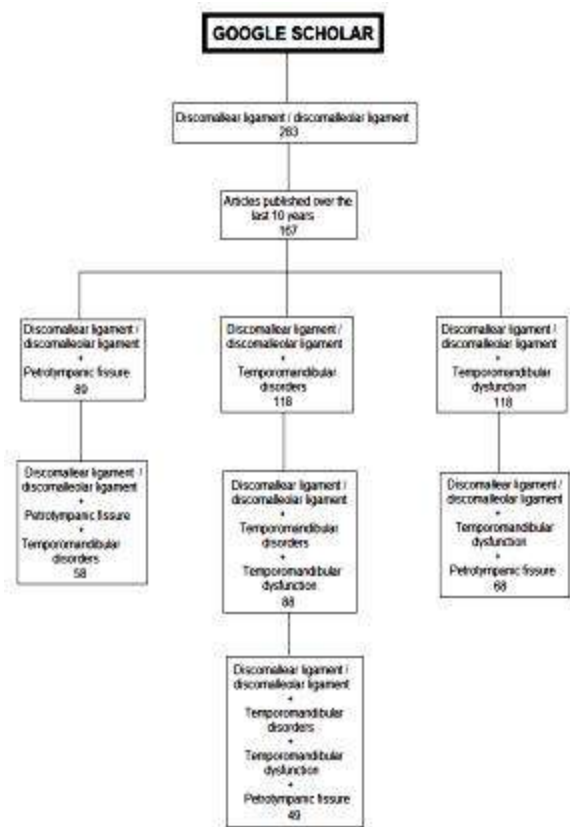


Fig.5: Google Scholar Keywords combination.

Papers extracted from the Google Scholar database:

- 1- A direct anatomical study of the morphology and functionality of disco-malleolar and anterior malleolar ligaments (ARISTEGUIETA; ACUNA; ORTIZ, 2009).
- 2- Anatomical study of the human discomalleolar ligament using cone beam computed tomography imaging and morphological observations (ARAI; SATO, 2011).
- 3- A study of the discomalleolar ligament in the adult human (ROWICKI; ZAKRZEWSKA, 2006).

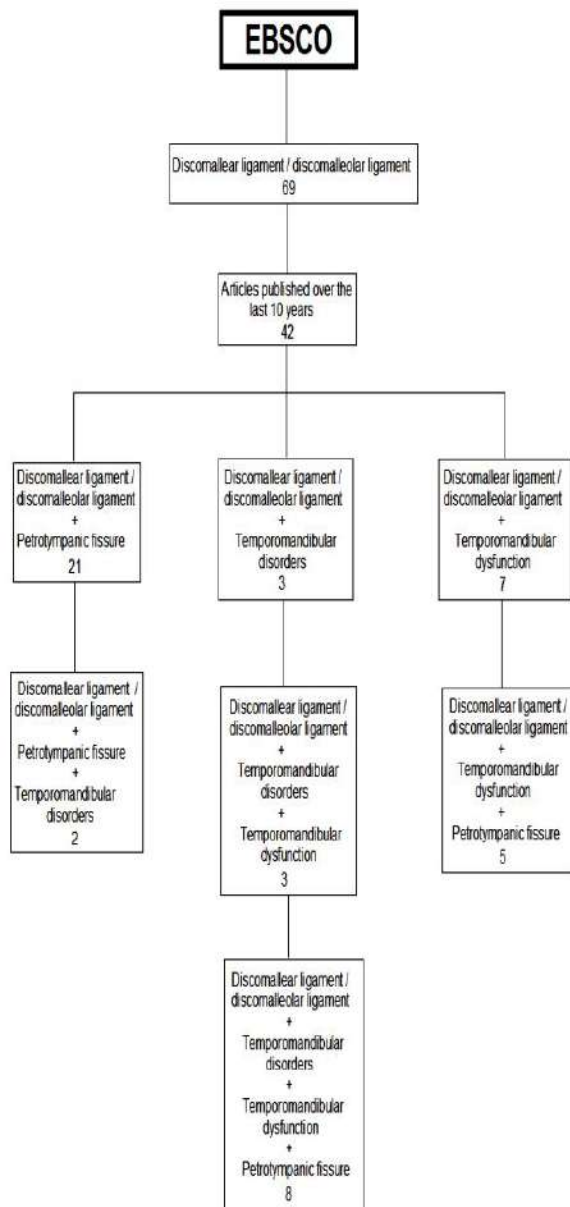


Fig.6: EBSCO Keywords combination.

Papers extracted from the EBSCO database:

- 1- Anatomical and functional aspects of ligaments between the malleus and the temporomandibular joint (SENCIMEN et al., 2008).
- 2- Signs and Symptoms of Temporomandibular Joint Disorders Related to the Degree of Mouth Opening and Hearing Loss (KITSOULIS et al., 2016).
- 3 - Ossification of the petrotympanic fissure: morphological analysis and clinical implications (MONTEIRO; ENNES; ZORZATTO, 2011).

III. RESULTS

Computed tomography (CT) and Anatomical Pieces Evaluation

It can be observed that the tomographic image (figure 7) used in the present study has a circular hypodense structure, in the region of the petrotympanic fissure, near the mandibular fossa of the temporal bone, suggestive of foramen and a possible passage of the discomalleolar ligament towards posterior region of the joint capsule of the disc of the temporomandibular joint.

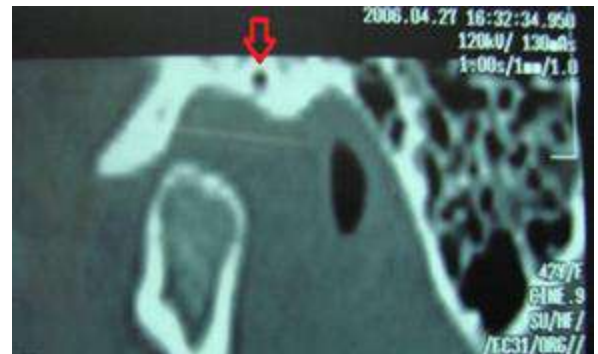


Fig.7: Possible place of passage of the discomalleolar ligament demonstrated by the red arrow.

The evaluation of the skulls resulted in two tables, one for adult skulls (table 1) and one for children's skulls (table 2). About adult skulls analyzed, 90% presented foramen on both sides, 1.44% presented foramen only on the right side, 4.33% presented foramen only on the left side, and 3.61% presented no foramen on either side. Of the children's skulls, 33.3% had a foramen on both sides, 33.3% on the right side, and 33.3% had no foramen on either side. Two images were obtained (Figures 8 and 9) in order to demonstrate to the naked eye, the presence of the foramina in the petrotympanic fissure.

Table 1: Analysis of absence or presence of foramen in the region of petrotympanic fissure in adult skulls.

	BOTH SIDES	JUST ON THE RIGHT SIDE	JUST ON THE LEFT SIDE
ABSENCE OF FORAME	10	X	X
PRESENCE OF FORAME	251	4	12

Table 2: Analysis of absence or presence of foramen in the region of petrotympanic fissure in children's skulls.

	BOTH SIDES	JUST ON THE RIGHT SIDE	JUST ON THE LEFT SIDE
ABSENCE OF FORAME	3	X	X
PRESENCE OF FORAME	3	3	0



Fig.8: Presence of foramen in the petrotympanic fissure on the right side, demonstrated by the red arrow.



Fig.9: Presence of foramen in the petrotympanic fissure on the left side, demonstrated by the red arrow.

Literature review

After analyzing the combination of the keywords used for this literature review, a table with a brief summary of each of the extracted papers was obtained (table 3).

Table 3: Summary of Articles included in this Review.

Authors	Objective	Methods	Results	Conclusion
Çakur et al. (2011)	To investigate the prevalence of petrotympanic fissure types in temporomandibular dysfunction with dental tomography and correlation with age.	134 TMD patients examined for type of petrotympanic fissure by means of dental tomography. Three types were described: wide tunnel structure (type 1); tunnelled structure at the entrance of the petrotympanic fissure that gradually decreases towards the tympanic cavity (type 2), a tunnel-shaped structure that is well open at the entrance of the mandibular fossa, with a flat shape in the middle and a narrow exit in the tympanic cavity (type 3).	In the DVT (dental tomography) scans, PTF (petrotympanic fissure) types 1, 2 and 3 were observed in 67.2%, 1.5% and 31.3% of the cases, respectively. We found no significant relationship between age or gender and PTF type`.	The low percentage of type 2 PTF and high percentage of type 1 PTF should be taken into account during pre-surgery planning related to TMD.
Sato et al. (2008)	To define the morphological characteristics of the discomalleolar ligament by Cone-Beam Computed	The CBCT of PSR 9,000 N (Asahi Roentgen Industry, Kyoto, Japan) was used to acquire temporomandibular	The CBCT images revealed three types of structures in the middle region of the petrotympanic fissure toward the malleus	The structures are important to define the malleus limited movement and the morphological characteristic of the

	Tomography (CBCT) and the anatomical dissection of Japanese cadavers.	joint images of 14 human cadavers that later had this region dissected.	bone: wide tunnel (29.2%, 7/24, type 1), a widely open tunnel form at the entrance of the petrotympanic fissure (20.8%, 5/24, type 2), and the tunnel form is widely open at the entrance of the mandibular fossa, with a tunnel and flat form in the middle and narrow exit in the tympanic cavity (41.7% 10/24, type 3).	ligaments in this bone may be related to temporomandibular joint pain, dysfunction and auditory function.
Alves et al. (2010)	To determine the frequency of occurrence of the discomalleolar ligament in the adult man.	20 hemi-heads dissected with the purpose of exposing the articular disc, ossicles of the middle ear, lateral pterygoid muscle and other structures of the region.	In all cases, the malleus and disc of the temporomandibular joint were connected by ligaments that formed a fibrous structure in the form of a thin blade.	The discomalleolar ligament was found in all cases and may be considered an intrinsic ligament of the temporomandibular joint.
Çakur et al. (2016)	To evaluate the correlation between tinnitus and petrotympanic fissure subtypes in patients diagnosed with temporomandibular joint dysfunction (TMD).	100 patients with TMD (50 with tinnitus, 50 without tinnitus) underwent concomitant computed tomography (CBCT) had the images analyzed and petrotympanic fissure classified as type 1 (wide tubular formation), type 2 (double conical structure) or type 3 (single conical structure).	Although there was a negative correlation between tinnitus and petrotympanic fissure type ($P < 0.001$), there was no correlation between age and tinnitus or between age and petrotympanic fissure subtype. There was no significant association between gender and tinnitus or petrotympanic fissure ($P > 0.05$).	A short and broad petrotympanic fissure (type 1) may be associated with a higher incidence of tinnitus in patients with TMD.
Ramirez et al. (2009)	Study of morphometric and functional aspects of anterior discomalleolar and malleolar ligaments.	3 temporal bone pieces of 12 cadavers were microdissected to expose ligaments under study. Electronic caliber (Mitutoyo) for recording measurements in mm and applying forces to the mandible for reproduction of some physiological and	Mean lengths of the anterior discomalleolar and malleolar ligaments of 6.88 mm (SD 0.81) and 4.22 mm (SD 1.17), respectively. Malleus movement with discomalleolar traction in 30.5% of samples. Correlation between the movement of the malleus and the length of the discomalleolar (R2	There was an anatomic and functional relationship between the human temporomandibular joint and the middle ear.

		pathological scenarios.	= -0.499, p <0.05). Both ligaments present in all specimens.	
Arai et al. (2011)	Study of the morphological, macroscopic, histological structure of the discomalleolar ligament (DML) and evaluation of neuronal structures within the distribution of substance P (SP) and peptide related to the calcitonin gene (CGRP).	Dissection and extraction of temporal bones containing the temporomandibular joint of 27 human cadavers. Parts submitted to concomitant computed tomography, measurements and immunohistochemical methods.	The posterior area of the DML articulates with the head and anterior process of the malleus through the petrotympanic fissure, forming a narrow channel. This was associated with bone mobility. In the anterior and posterior connective tissue of the DML associated with the disc, fibers of the nerves CGRP-, PGP9.5- and SP-positive were located around numerous blood vessels.	The structure of the petrotympanic fissure by which the discomalleolar ligament attaches to the malleus, as well as the histological and radiographic profiles of its structure, showed a relation with the mobility of the malleus.
Rowicki et al. (2006)	To determine the frequency of occurrence and morphology by means of endoscopic visualization of the discomalleolar ligament (DML) and its attachments, and if the applied tension could trigger the movement of the malleus.	Evaluate of 14 samples of the temporomandibular and tympanic cavity by means of an endoscope and then by coarse dissection of an operating microscope.	4 cases had a strip of tissue in the temporomandibular joint, known as Pinto's ligament. Presence of DML in 11 cases, triangular in 7 cases, and longitudinal in 4 cases. Malleus movement present in 3 cases.	There is a clear connection between the temporomandibular joint and the tympanic cavity.

Kitsoulis et al. (2011)	Examination of the relation between signs and symptoms of temporomandibular dysfunction (TMD) and mouth opening, gender, joint and auditory symptoms and hearing loss.	464 university students. Mouth opening measured with Vernier calipers. Anamnestic questionnaire applied to stratify them into four groups based on the severity of TMD. Hearing symptoms and a recorded audiogram for each subject as well.	Overall incidence of signs and symptoms of TMD were 73.3%, higher in women (p-value 0.0001 <0.05). Hearing symptoms were associated with TMD severity (p-value 0.0001 <0.05) as well as maximum mouth opening (p-value 0.004 <0.05). Audiometry showed that moderate and severe TMD was associated with hearing loss of medium and low tones, respectively (p-value 0.0001 <0.05). TMJ pain (p value 0.0001 <0.05), TMJ ankylosis (p-value 0.0001 <0.05), bruxism (p-value 0.0001 <0.05) and ear itching (p-value 0.0001 <0.05) were also statistically different between TMD and non-TMD.	Signs and symptoms of TMD are more common and severe in women. The severity of TMD correlated with the degree of mouth opening and the number of auditory symptoms. The absence or presence of mild TMD was associated with normal audiograms, while moderate and severe TMD were related to hearing loss in low and low tones, respectively. Bruxism, joint ankylosis, joint pain and ear itching were more common in TMD than patients without TMD.
Sencimen et al. (2008)	To investigate the anatomical topography and the relation between the ligaments, malleus and temporomandibular joint and to determine the role of these ligaments in the movement of the malleus.	The malleus, incus, petrotympanic fissure (PTF), chorda tympani, anterior malleolar ligament (AML), discomalleolar ligament (DML), malleomandibular ligament, sphenomandibular ligament and disc joint were explored in 15 skulls. Tensile and tensile tests performed to clarify the role of these structures in the movement of the malleus.	In 12 cases two ligaments connected to the anterior part of the malleus. Of this same portion, another ligament that went to PTF was seen in 3 cases. In all of cases, the DML joined the retrodiscal tissues. In the other 3 cases, the medial and lateral parts of the ligament were attached to the retrodiscal tissue after passage through PTF. The thickness of the ligaments differed among the specimens. When the tension was applied to the DML, no malleolar movement	The overstretched of the condyle together with the ligaments between the inner ear ossicles and the TMJ may be the reason for unexplained otological problems.

			occurred, but when the AML was overloaded, the movement was significant in 5 corpses; small movement in 6 corpses, and no movement in 4 corpses.	
Monteiro et al. (2011)	To characterize morphologically the calcification in the petrotympanic fissure through three observations: macroscopic observation to the naked eye, stereomicroscopic observation and measurements made from digital images.	Macroscopic and stereomicroscopic analysis of the petrotympanic fissure of 30 human skulls. Analysis of scanned images with the UTHSCSA ImageTool 3.0 computer program. Measurement of the total extension of the areas of cracks and ossification.	Macroscopic analysis: areas suggestive of calcification in 27 fissures (45%). Stereomicroscopic analysis: areas of calcification in 40 fissures. (66.6%). The location of the areas of calcification was not regular considering the total length of the various fissures and their division into median and lateral regions, occurring randomly along the total length of the fissures.	Macroscopic analysis was not an appropriate method for this evaluation and the ossification of fissures increased with aging, suggesting its influence on the causes of otalgia in cases of temporomandibular joint dysfunction.

IV. DISCUSSION

The aim of the present study was to perform a systematic review of the presence of the discomalleolar ligament, its possible influences on otological symptoms and correlation with temporomandibular dysfunction. Therefore, the methods evaluated and the studies analyzed shows the anatomical relationship between the tympanic cavity and temporomandibular joint, as well as the existence of the discomalleolar ligament and its possible influence on the otologic symptoms caused by temporomandibular disorders.

In addition, several studies state that there is an obvious anatomic and functional relationship between temporomandibular joint and the tympanic cavity (RODRÍGUEZ VÁZQUEZ, MÉRIDA VELASCO, MÉRIDA VELASCO, & JIMÉNEZ COLLADO, 1998)(CHEYNET et al., 2003)(ROWICK & ZAKRZEWSKA, 2006)(RAMÍREZ ARISTEGUIETA et al., 2009) (ÇAKUR, SÜMBÜLLÜ, DURNA, & AKGÜL, 2011). The discomalleolar ligament is one of the structures that allows this relationship and is not described in anatomical books (PATURET, 1951)(SAPPEY, 1867)(CRÉPY, 1967)(TESTUT & LATARJET, 1975)(ROMANES, 1987)(ROUVIÈRE & DELMAS, 1987)(DUBRUL, 1990)(WILLIAMS, 1995). This

ligament consists of a layer of superior fibers that insert into the anterior malleus process and the bone wall of the squamous portion of the petrotympanic fissure, and a layer of inferior fibers surrounding the anterior malleolar ligament (AML), the remnant of Meckel's cartilage, the chorda tympani and insert into the tympanic wall of the temporal bone (OGÜTCEN-TOLLER, 1995). Besides, it is considered an intrinsic ligament of the temporomandibular joint (RODRÍGUEZ VÁZQUEZ, MÉRIDA VELASCO, & JIMÉNEZ COLLADO, 1992)(RODRÍGUEZ VÁZQUEZ, J et al., 1993)(RODRÍGUEZ VÁZQUEZ et al., 1998)(ALVES & DEANA, 2010).

Some authors consider discomalleolar ligament as part of AML (BURCH, 1966)(TOLEDO FILHO, ZORZETTO, & NAVARRO, 1985)(CESARIANI, TOMBOLINI, FAGNANI, & DOMENECH MATEU, 1991), superior extension of the sphenomandibular ligament in the tympanic cavity (BURCH, 1966) or the "small ligament" described by Pinto in 1962 (PINTO, 1962). In contrast, other authors do not agree with the statement that AML and discomalleolar ligament are part of the same structure and say that there is a well-established difference between them (COLEMAN, 1970)(KOMORI, SUGISAKI, TANABE, & KATOH, 1986)(OGÜTCEN-

TOLLER, 1995)(RODRÍGUEZ VÁZQUEZ et al., 1998)(Dai, Cheng, Wood, & Gan, 2007)(SENCIMEN et al., 2008).

Individuals with temporomandibular dysfunction may frequently exhibit otological symptoms. The dissonance of the stomatognathic system, such as muscular pain, TMJ pain, cervical pain, tooth sensitivity, joint noise and, in general, functional difficulties, were significantly associated with otologic symptoms in cases of temporomandibular disorders (FELICIO et al., 2004)(KITSOULIS, MARINI, ILIOU, GALANI, & ZIMPIS, 2011)(ÇAKUR & YAŞA, 2016).

The discomalleolar ligament presents mobility as it passes through petrotympanic fissure, caused by stretches in the TMJ disc during movements of the mandible (COULY & HUREAU, 1976)(CESARIANI et al., 1991)(SATO, ARAI, IMURA, KAWAI, & YOSUE, 2008)(ARAI & SATO, 2012). Consequently, it is believed that the mobility of this ligament according to the degree of closure of petrotympanic fissure determined during development may affect the movement of the middle ear bones (RODRÍGUEZ VÁZQUEZ et al., 1998). Some authors state that malleus mobility was observed when the discomalleolar ligament was overloaded (IOANNIDES & HOOGLAND, 1983)(O'RAHILLY & GARDNER, 1976)(PINTO, 1962)(TOLEDO FILHO et al., 1985). Nonetheless, other authors say that there is no evidence that discomalleolar ligament can cause movement of this ossicle chain (COLEMAN, 1970)(KOMORI et al., 1986)(LOUGHNER, LARKIN, & MAHAN, 1989)(ECKERDAL, 1991)(OGÜTCEN-TOLLER, 1995)(SENCIMEN et al., 2008).

The morphological characteristics of the ligament as well as its mobility may influence the movement of the malleus. This observation could strengthen the hypothesis of origin of pain in TMJ and of otalgia's (IOANNIDES & HOOGLAND, 1983)(RODRÍGUEZ VÁZQUEZ et al., 1998)(SATO et al., 2008)(SENCIMEN et al., 2008). Some authors have made a relation between the ligament in question and certain otologic manifestations caused by temporomandibular disorders (IOANNIDES & HOOGLAND, 1983)(Rohlin, Westesson, & Eriksson, 1985)(LOUGHNER et al., 1989)(OGÜTCEN-TOLLER & JUNIPER, 1993). Tinnitus may be due to the transmission of excessive mechanical forces by discomalleolar ligament (PEKKAN, AKSOY, Hekimoglu, & Oghan, 2010)(RAMÍREZ ARISTEGUIETA et al., 2009)(ASH, ASH, ASH, & ASH, 1990). It may also be a possible pathway for the spread of infection from the middle ear to temporomandibular joint, such as otitis media, which can, through petrotympanic fissure, cause

capsulitis or even rupture of the ossicle joint (LOUGHNER et al., 1989). In contrast, other authors say that the ligament has no role in otological manifestations (CHEYNET et al., 2003)(ALVES & DEANA, 2010), because it does not contain sufficient force to mobilize the bones of the middle ear once it is firmly adhered to petrotympanic fissure (ALVES & DEANA, 2010).

V. CONCLUSION

For this purpose, that the methods evaluated and the studies analyzed show the anatomical relationship between the tympanic cavity and the temporomandibular joint, as well as the existence of the discomalleolar ligament and its possible influence on the otologic symptoms caused by temporomandibular disorders.

REFERENCES

- [1] ALVES, N., & DEANA, N. F. (2010). Frequency of Occurrence of the Discomalleolar Ligament in the Adult Man. *International Journal of Morphology*, 28(2), 515–518. <https://doi.org/10.4067/s0717-95022010000200029>
- [2] ARAI, H., & SATO, I. (2012). Anatomical study of the human discomalleolar ligament using cone beam computed tomography imaging and morphological observations. *Okajimas Folia Anatomica Japonica*, 88(3), 89–101. <https://doi.org/10.2535/ofaj.88.89>
- [3] ASH, M., ASH, C., ASH, J., & ASH, G. (1990). Current concepts of the relationship and management of temporomandibular disorders and auditory symptoms. *J Mich Dent Assoc*, 72(11–12), 550–555.
- [4] BOCHENEK, A., & REICHER, M. (1997). *Anatomia Humana* (11th ed.). Warszawa: PZWL.
- [5] BURCH, J. G. (1966). The cranial attachment of the sphenomandibular (tympanomandibular) ligament. *The Anatomical Record*, 156(4), 433–437.
- [6] ÇAKUR, B., SÜMBÜLLÜ, M., DURNA, D., & AKGÜL, H. (2011). Prevalence of the types of the petrotympanic fissure in the temporomandibular joint dysfunction. *Acta Radiol*, 52(5), 562–565.
- [7] ÇAKUR, B., & YAŞA, Y. (2016). Correlation Between Tinnitus and Petrotympanic Fissure Status Among Patients With Temporomandibular Joint Dysfunction. *J Oral Maxillofac Surg*, 74(1), 47–52.
- [8] CESARIANI, A., TOMBOLINI, A., FAGNANI, E., & DOMENECH MATEU, J. (1991). The anterior ligament of the human malleus. *Acta Anat (Basel)*, 42(4), 313–6.
- [9] CHEYNET, F., GUYOT, L., RICHARD, O., LAYOUN, W., & GOLA, R. (2003). Discomalleolar and maleomandibular ligaments: Anatomical study and clinical applications. *Surgical and Radiologic Anatomy*, 25(2), 152–157. <https://doi.org/10.1007/s00276-003-0097-y>
- [10] COLEMAN, R. D. (1970). Temporomandibular Joint: Relation of the Retrodiskal Zone to Meckel's Cartilage and Lateral Pterygoid Muscle. *Journal of Dental Research*,

- 49(3), 626–630.
<https://doi.org/10.1177/00220345700490032701>
- [11] COULY, G., & HUREAU, J. (1976). [The oto-menisal relationship of temporo-mandibular joint in the new-born man (author's transl)]. *Arch Anat Histol Embryol.*, 59, 143–50.
- [12] CRÉPY, C. (1967). *Anatomie Cervico-Faciale*. (1st ed.). Paris: Masson.
- [13] Dai, C., Cheng, T., Wood, M. M., & Gan, R. Z. (2007). Fixation and detachment of superior and anterior malleolar ligaments in human middle ear: Experiment and modeling. *Hear Res*, 230(1–2), 24–33.
- [14] DUBRUL, E. . (1990). *Anatomia Oral*. Barcelona: Ediciones Doyma.
- [15] ECKERDAL, O. (1991). The petrotympanic fissure: a link connecting the tympanic cavity and the temporomandibular joint. *Cranio*, 9(1), 15–22.
- [16] FELICIO, C., FARIA, T., & DA SILVA, M. A. M. . (2004). Desordem Temporomandibular: relações entre sintomas otológicos e orofaciais. *Rev Bras Otorrinolaringol*, 70(6), 786–793.
- [17] FURSTMAN, L. (1963). The early development of the human temporomandibular joint. *American Journal of Orthodontics*, 49(9), 672–682.
- [18] IOANNIDES, C. A., & HOOGLAND, G. A. (1983). The disco-malleolar ligament: A possible cause of subjective hearing loss in patients with temporomandibular joint dysfunction. *Journal of Maxillofacial Surgery*, 11(C), 227–231. [https://doi.org/10.1016/S0301-0503\(83\)80053-8](https://doi.org/10.1016/S0301-0503(83)80053-8)
- [19] KITSOULIS, P., MARINI, A., ILIOU, K., GALANI, V., & ZIMPIS, A. (2011). Signs and Symptoms of Temporomandibular Joint Disorders Related to the Degree of Mouth Opening and Hearing Loss. *BMC Ear Nose Throat Disord*, 11(5).
- [20] KOMORI, E., SUGISAKI, M., TANABE, H., & KATOH, S. (1986). Discomalleolar Ligament in the Adult Human. *Cranio*, 4(4), 299–305.
- [21] LAM, D., LAWRENCE, H., & TENENBAUM, H. (2001). Aural symptoms in temporomandibular disorder patients attending a craniofacial pain unit. *J Orofac Pain*, 15(2), 146–157.
- [22] LOUGHNER, B. A., LARKIN, L. H., & MAHAN, P. E. (1989). Discomalleolar and anterior malleolar ligaments: Possible causes of middle ear damage during temporomandibular joint surgery. *Oral Surgery, Oral Medicine, Oral Pathology*, 68(1), 14–22. [https://doi.org/10.1016/0030-4220\(89\)90108-4](https://doi.org/10.1016/0030-4220(89)90108-4)
- [23] MORGAN, D. . (1982). *Diseases of the tempormandibular apparatus: A multidisciplinary aproach*. Toronto: Mosby.
- [24] O'RAHILLY, R., & GARDNER, E. (1976). *The embryology of bone and joints*. IAP.
- [25] OGÜTCEN-TOLLER, M. (1995). The morphogenesis of the human discomalleolar and sphenomandibular ligaments. *J Craniomaxillofac Surg*, 23(1), 42–6.
- [26] OGÜTCEN-TOLLER, M., & JUNIPER, R. (1993). Audiological evaluation of the aural symptoms in temporomandibular joint dysfunction. *J Craniomaxillofac Surg*, 21(1), 2–8.
- [27] PASCOAL, M. I. N. (2001). Prevalência dos sintomas otológicos na desordem temperomandibular: estudo de 126 casos. *Rev. Bras. Otorrinolaringol*, 67(5), 627–633.
- [28] PATURET, G. (1951). *Traité d'anatomie humaine* (1st ed.). Masson.
- [29] PEKKAN, G., AKSOY, S., Hekimoglu, C., & Oghan, F. (2010). Comparative audiometric evaluation of temporomandibular disorder patients with otological symptoms. *J Craniomaxillofac Surg*, 38(3), 231–234.
- [30] PINTO, O. (1962). A new structure related to the temporomandibular joint and middle ear. *The Journal of Prosthetic Dentistry*, 12(1), 95–103.
- [31] RAMÍREZ ARISTEGUIETA, L. M., BALLESTEROS ACUÑA, L. E., & SANDOVAL ORTIZ, G. P. (2009). A Direct Anatomical Study of the Morphology and Functionality of Disco-malleolar and Anterior Malleolar Ligaments. *International Journal of Morphology*, 27(2), 367–379. <https://doi.org/10.4067/s0717-95022009000200011>
- [32] REES, L. . (1954). The structure and function of mandibular joint. *Br Dent J*, 96, 125–133.
- [33] RODRÍGUEZ VÁZQUEZ, J. F., MERÍDA VELASCO, J. R., & JIMÉNEZ COLLADO, J. (1993). Relationships between the temporomandibular joint and the middle ear in human fetuses. *J Dent Res*, 72(1), 62–66.
- [34] RODRÍGUEZ VÁZQUEZ, J. ., MÉRIDA VELASCO, J. ., & JIMÉNEZ COLLADO, J. (1992). Development of the human sphenomandibular ligament. *Anatomical Record*, 233(3), 453–460.
- [35] RODRÍGUEZ VÁZQUEZ, J. ., MÉRIDA VELASCO, J. ., MÉRIDA VELASCO, J. ., & JIMÉNEZ COLLADO, J. (1998). Anatomical considerations on the discomalleolar ligament. *J Anat*, 192(4), 617–621.
- [36] Rohlin, M., Westesson, P., & Eriksson, L. (1985). The correlation of temporomandibular joint sounds with joint morphology in fifty-five autopsy specimens. *J Oral Maxillofac Surg*, 43(3), 194–200.
- [37] ROMANES, G. J. (1987). *Cunningham Tratado de Anatomia*. Madrid: Interamericana-McGraw-Hill.
- [38] ROUVIÈRE, H., & DELMAS, A. (1987). *Anatomia Humana: Descriptiva, Topografica y Funcional* (1st ed.). Barcelona: Masson.
- [39] ROWICK, T., & ZAKRZEWSKA, J. (2006). A study of the discomalleolar ligament in the adult human. *Folia morphologica*, 65(2), 121–125.
- [40] SAPPEY, P. (1867). *Traite d'anatomie descriptive* (1st ed.). Paris: Acta Anat.
- [41] SATO, I., ARAI, H., IMURA, K., KAWAI, T., & YOSUE, T. (2008). Classifications of tunnel-like structure of human petrotympanic fissure by cone beam CT. *Surg Radiol Anat*, 30(4), 323–326.
- [42] SENCIMEN, M., YALCIN, B., DOĞAN, N., VAROL, A., OKÇU, K., OZAN, H., & AYDINTUĞ, Y. (2008). Anatomical and functional aspects of ligaments between

the malleus and the temporomandibular joint. *Int J Oral Maxillofac Surg*, 37(10), 943–947.

- [43] STANDRING, S. (2005). *Gray's anatomy: The anatomical basis of clinical practice* (39th ed.). Edinburgh: Elsevier.
- [44] TESTUT, L., & LATARJET, A. (1975). *Tratado de Anatomia Humana*. Barcelona: Salvat Editores.
- [45] TOLEDO FILHO, J., ZORZETTO, N., & NAVARRO, J. (1985). Structures and relationships of the anterior malleus ligament. *Anatomischer Anzeiger*, 158(1), 13–22.
- [46] WILLIAMS, P. (1995). *Gray's Anatomy*. London: Churchill Livingstone.
- [47] YUODELIS, R. (1966). The morphogenesis of the human temporomandibular joint and its associated structures. *J Dent Res*, 45(1), 182–191.

Narratives of Health Professionals Relating to Scarce Resources in an Urgency Service

Narrativas De Profissionais De Saúde Relativas A Recursos Escassos Em Um Serviço De Urgência

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Abstract— *This study aimed to analyze the narratives of health professionals working in a Emergency Care Unit that deal with decision making in situations of scarce resources. An exploratory research, of a qualitative nature, was carried out through a narrative interview technique with 25 professionals. Three categories emerged from the study: Decision making in the face of scarce resources; Ethical conflicts; Academic preparation for confrontation and the sentimental framework. Prioritization of patients is a reality in this health service. The prevalent problems are the scarcity of materials and medicines and the lack of human resources. The discourse preached the lack of ethical preparation of the academy for decision making. Most of the interviewees believe that they had little preparation to face the reality of the service. Some interviewees showed feelings of regret, impotence, insecurity, desire to abandon service, anguish and personal conflicts in the face of the wear and tear caused by the situation. It is necessary to invest in constant dialogues, health education and awareness-raising strategies in order to contribute to consensual actions that best subsidize decision-making in situations of scarce resources and that favor equitable health care in order to maximize benefits and reorient processes job.*

Keywords— *Emergency Care Unit, Health Professionals, Ethical conflicts.*

Resumo— *Este estudo objetivou analisar as narrativas de profissionais de saúde atuantes em uma Unidade de Pronto Atendimento que lidam com a tomada de decisão em situações de recursos escassos. Realizou-se uma pesquisa exploratória, de natureza qualitativa, através da técnica de entrevista narrativa com 25 profissionais. Do estudo emergiram três categorias: Tomada de decisão frente a escassez de recursos; Conflitos éticos; Preparo acadêmico para o enfrentamento e o arcabouço sentimental. A priorização de pacientes é uma realidade neste serviço de saúde. Os problemas prevalentes são a escassez de materiais e medicamentos e a falta de recursos humanos. Prevaleceu o discurso da falta de preparo ético da academia para com a tomada de decisão. A maioria dos entrevistados acredita que teve pouco preparo para enfrentar a*

realidade do serviço. Alguns entrevistados demonstraram sentimentos de pesar, impotência, insegurança, desejo de abandono do serviço, angústia e conflitos pessoais em face do desgaste causado pela situação. É necessário investir em constantes diálogos, educação em saúde e estratégias de sensibilização de forma a contribuir para ações consensuais que melhor subsidiem a tomada de decisão em situação de recursos escassos e que favoreçam o cuidar em saúde equânime de forma a maximizar benefícios e reorientar processos de trabalho.

Palavras-chave— *Unidade de Pronto Atendimento, Profissionais da Saúde, Conflitos éticos.*

I. INTRODUÇÃO

Nos cenários dos serviços de urgência e emergência existem situações rotineiras como a necessidade da microalocação de recursos escassos, em que se faz necessária a tomada de decisão que deve ser alicerçada por princípios bioéticos. Tal prática é protagonizada por médicos, enfermeiros e outros profissionais que lidam com a fragilidade que o cenário lhes impõe, uma vez que existe o risco iminente de morte do paciente^{9,10}.

No campo prático da saúde pública, a alocação de recursos tem sido um sério problema enfrentado, o que justifica reflexões norteadas pela Bioética neste contexto, que compreenda e envolva as excentricidades que possuem os países em desenvolvimento¹¹.

A microalocação de recursos está relacionada à discussão e análise das formas de seleção individualizada de pessoas que serão beneficiadas pelos serviços disponíveis, uma vez que estes são escassos. Para tanto, podemos citar como exemplos de recursos escassos: estrutura hospitalar insuficiente; falta de leitos; número insuficiente de profissionais; restrição de acesso a drogas e insumos de maior eficácia e eficiência e a equipamentos tecnológicos¹⁰⁻¹².

Por outro lado, destaca-se que nem sempre a abordagem ética se apresenta como tema de conhecimento suficiente para profissionais de saúde e tomadores de decisão. Parte-se da hipótese de que algumas decisões são originárias de discussões coletivas com participação da equipe, entretanto, concebê-las é extremamente desafiador, conflitante, estressante e causador de sofrimento¹⁰⁻¹³.

Este estudo teve por objetivo analisar as narrativas de profissionais de saúde atuantes em uma Unidade de Pronto Atendimento que lidam com a tomada de decisão em situações de recursos escassos.

A discussão sobre esta temática ainda é incipiente¹³ e o cenário atual vem sofrendo danosas imposições que comprometem a vivacidade do Sistema de Saúde vigente. Convive-se com restrição de investimentos em virtude da crise política-econômica, do subfinanciamento crônico e de políticas privatizantes¹⁴ contribuindo ainda mais para os desgastes dos serviços e atenção inadequada à saúde.

II. METODOLOGIA

Trata-se de uma pesquisa exploratória, de natureza qualitativa, utilizando por estratégia a técnica da narrativa que configura-se como um método não estruturado que possibilita aflorar histórias de vida dos entrevistados entremeadas ao contexto situacional¹⁵.

O estudo foi aprovado pelo Núcleo de Ensino, Pesquisa e Extensão da instituição coparticipante e pelo Comitê de Ética em Pesquisa da Universidade Federal de Minas Gerais, sob o número CAAE: 5421211600005149.

O cenário foi uma Unidade de Pronto Atendimento da cidade de Belo Horizonte, Minas Gerais, Brasil, tendo como participantes 10 enfermeiros e 15 médicos que atenderam aos seguintes critérios de inclusão: trabalhar na unidade há pelo menos um ano e exercer dentre suas funções laborais, a tomada de decisão no que se refere à microalocação em situação de recursos escassos.

A coleta de dados ocorreu entre os meses de junho a agosto de 2016, sendo a abordagem do entrevistador determinada pela solicitação “*relate sua experiência sobre a tomada de decisão em situações de recursos escassos no âmbito da microalocação*”.

As entrevistas, individuais, foram realizadas em local e horário pré-determinado pelos participantes, e com permissão prévia foram gravadas. Nenhum dos participantes desistiu durante este processo. Todos foram identificados pelas letras “TD” (Tomador de Decisão) acompanhadas de um número inteiro diferente. A amostra foi considerada satisfatória e a repetição de depoimentos com as mesmas características e informações caracterizou a saturação dos dados, quando se atingiu o total de 25 participantes.

Para a análise dos dados, operou-se com a diminuição do texto transcrito de forma gradativa, trabalhando-se com condensação de sentido e generalização, como proposto por Muylaert *et al*¹⁵ para a análise de entrevistas narrativas, emergindo as seguintes categorias: (1) *Tomada de decisão frente a escassez de recursos*; (2) *Conflitos éticos*; (3) *Preparo acadêmico para o enfrentamento e o arcaçouço sentimental*.

Para traçar o perfil dos participantes da pesquisa, utilizou-se de um formulário com variáveis relativas ao

gênero, formação, idade, e tempo de atuação profissional, que foram preenchidos pelos mesmos no ato da abordagem.

III. RESULTADOS

Dos participantes 76% eram do sexo feminino, entre estes, 60% dos entrevistados atuavam como médicos e os outros 40% atuavam como enfermeiros. No que tange a idade, 12% dos participantes possuíam até 45 anos, no entanto a maior porção apresenta ter de 26 à 30 anos, representando 40% do volume total. Quanto ao tempo em que trabalhavam no estabelecimento de saúde, 56% dos entrevistados afirmam dispor de até 5 anos de atuação profissional; 40%, possuíam até 11 anos; e 4% relataram uma experiência superior a 12 anos.

Tomada de Decisão frente à escassez de recursos

Os discursos indicaram que a priorização de pacientes é uma realidade, sendo enfrentada levando-se em consideração critérios como idade, prognóstico e chances de sobrevivência.

“(...) a escolha passa, por exemplo, isso na minha opinião, nesse caso que eu tive, foi pela idade da paciente (...)” (TD19)

“A gente tenta priorizar mais jovem porque, né, tem uma vida toda pela frente, o idoso já tá chegando, dizemos assim, né, no fim da vida”. (TD14)

“O estado clínico do paciente. Paciente que tá mais grave, a idade do paciente e o tempo que o paciente tá aqui já”. (TD02)

“Olha, a gente vê quem tá mais grave e quem tem mais chance de sobreviver, então se eu tenho dois pacientes igualmente graves e eu só posso dar atenção a um”. (TD21)

Entretanto, existiram relatos em que não houve a necessidade de priorização de pacientes por possuir profissionais suficientes para o atendimento.

“Se for o caso eu chamo outro colega que tá lá na porta e tudo, pra eu não, né, priorizar um paciente em detrimento de outro, então assim eu não priorizo um paciente em detrimento de outro não.” (TD09)

“Quando a gente tem mais de um paciente grave, aqui e nas outras unidades que eu trabalho, a gente tem um colega que pode atender quando tem mais de um.” (TD22)

A priorização de paciente passou também por escolher aquele que seria encaminhado para internação quando o serviço de referência disponibiliza a vaga, já que as vagas disponíveis para internação são insuficientes no julgamento dos entrevistados.

“(...) já troquei uma vaga é...porque na minha opinião naquele momento o outro precisava muito mais.

Mas então eu fiz, né, teoricamente eu tirei de um pra colocar o outro né.” (TD07)

Houve relato sobre dificuldade em identificar até que ponto a adoção de determinadas práticas para a tomada de decisão foi considerada assertiva, isto, justificado pelos participantes pela falta de *feedback* e do treinamento em serviço.

“É sentar mesmo com ele, falar assim, olha que tipo de conflito que você já vivenciou? E qual foi a sua tomada de decisão? Olha se você tivesse feito isso aqui seria melhor do que essa decisão sua tomada (...) Eu acho que antes de tudo... a educação continuada ela deveria existir.” (TD23)

Sobre a participação de outros membros da equipe na tomada de decisão prevaleceu à tomada de decisão conjunta e uma entrevistada remeteu à família como ponto de apoio nesse processo.

“Eu sempre costumo recorrer aos médicos, aos meus colegas e quem tem mais preparo do que eu”. (TD03)

“(...) quando é algum paciente crítico na unidade, há um consenso entre a equipe né e entre o médico, enfermeiro, família”. (TD24)

A perspectiva de continuidade do atendimento em outros níveis de atenção também foi considerada como um fator para tomarem decisão. Além de ser notório o relato da problemática frente à existência ou não de vaga, principalmente quanto à transferência para os serviços de referência.

“A gente faz contato e não consegue transferir os pacientes, né, então assim infelizmente a gente acaba ficando com esse paciente e muitas vezes até o óbito...” (TD07)

“O paciente fica aqui séculos, paciente que excede a nossa complexidade de atuação e o paciente fica aqui porque muitas vezes a gente não consegue transferir, entendeu!?” (TD09)

“(...)eu selecionei aquele que naquela situação teria mais condições de continuar, que eu teria condições de conseguir um CTI pra ele, que eu teria condições de uma transferência, de um tratamento e ele sair daquela situação e o outro infelizmente eu tive que tratar com que eu tinha pra oferecer, e infelizmente ele veio a falecer” (TD11)

As narrativas sobre a experiência vivida em situação de recursos escassos convergiram com relação aos principais tipos de escassez: equipamentos e estrutura, recursos humanos e medicamentos.

“acho que a nossa pior dificuldade é o recurso humano porque esse não tem como você reinventar, não tem como você fazer aparecer um funcionário” (TD24)

“simplesmente cê não tem o recurso, cê não tem o leito pro paciente, cê não tem medicação... então assim, é difícil” (TD19)

Conflitos éticos

Foi evidente a divergência, apreensão e dificuldade dos entrevistados em relatarem suas experiências no que tange aos aspectos éticos relacionados à prática da tomada de decisão e priorização de pessoas. Algumas narrativas estiveram imbuídas nos problemas que emergem da escolha daquele que será preterido em virtude da escassez do recurso:

“Fica na nossa mão um papel de julgar quem deve e não deve... Quem deve ganhar e quem não deve” (TD12)

“Acho que escolher quem vai sobreviver, pra mim é absurdo (risos) escolher quem vai seguir é uma coisa que é anti-ético, infelizmente é uma realidade...” (TD10)

Alguns relatos se fundamentaram em critérios clínicos e objetivos para responder às questões éticas envolvidas na priorização de pacientes. Os entrevistados consideraram que atitudes não éticas estariam relacionadas à escolha baseada em aspectos socioeconômicos.

“Eu acho que a questão ética ela ficaria mais evidente se você escolhesse esse paciente por um critério subjetivo, se você escolher aquele paciente por questão econômica, por raça, alguma coisa desse tipo, eu acho que quando cê está usando um critério de gravidade, cê está usando o critério médico, entendeu!?” (TD11)

“(...) a gente tem a ética com paciente, né, a gente não discrimina ele por nenhum motivo não (...). Eu vou ver o que ele é, o que é o ser humano, o que que ele tá precisando (...) o que ele é ou deixa de ser, isso não faz, num influencia para escolha de qual paciente vai ter a prioridade na assistência devido a escassez de recurso não.” (TD14)

Outros discursos mostraram uma visão “minimalista” em que a priorização de paciente estaria relacionada ao processo de Acolhimento com Classificação de Risco.

“A gente num tem uma escolha ética ou não, não tem uma visão ética ou não, todo paciente recebe o atendimento que tem na UPA, no entanto, de acordo com protocolo de Manchester” (TD23)

“Partindo do pressuposto que eles já foram classificados por uma questão de risco, eu acho que eticamente a gente tem obrigação de atender nessa evolução, né” (TD22)

Prevaleceu o discurso da falta de conhecimento ético oriundo da academia para a tomada de decisão e priorização de pessoas.

“Não, a gente não vê isso na teoria, a gente aprende só na prática depois que você pega né... que você começa a trabalhar, que você começa a ver, enfrentar as dificuldades (...) a gente não tem essa preparação na graduação, muito menos na pós-graduação, é muita teoria e pouco né... pouca prática” (TD24)

“Não! Acho que é mais com o dia-a-dia que a gente vai adquirindo esse preparo mesmo. Eu acho que na minha graduação que foi o básico” (TD01)

“Chegar aqui e vivenciar uma outra realidade é um pouco complicado, eu não tive preparo pra isso” (TD10)

Preparo acadêmico para o enfrentamento e o arcabouço sentimental

A percepção dos entrevistados sobre o preparo que possuem para a tomada de decisão envolvendo a sobrevida de pacientes em meio a recursos escassos permite entender a fragilidade no que tange o preparo profissional, sobretudo, no que diz respeito ao preparo acadêmico sobre a questão.

“(silêncio) Olha, eu acho que a tomada de decisão, eu, eu acho que... eu tive... eu tive capacitação para isso (...) mas eu acho que eu não fui capacitada com a priorização de paciente. Eu acho que eu fui capacitada para uma realidade que eu não encontrei, eu não me deparei, eu acho que a faculdade é excelente só que ela tá um pouco, as vezes, longe da nossa realidade (...)” (TD23)

“(silêncio) apanhando todo dia, aí cê vai aprendendo a lidar com isso (...) por mais que você forme em uma boa faculdade (...) você ainda sai despreparado para enfrentar muita coisa, você tem um conhecimento teórico mas a prática ainda... ce aprende demais aqui trabalhando.” (TD11)

Algumas falas remetem a perplexidade que os profissionais carregam em virtude do cenário em que trabalham.

“(...) eu simplesmente não consigo não deixar de me importar, isso para mim é o pior. Então, assim, psicologicamente falando, que o médico e enfermeiro que tá nessa situação, a gente sofre com isso, então preparo nenhum, eu saio e não aceito.” (TD19)

“Eu acho que na graduação nós deveríamos assim, (...) ser mais preparados para isso (...) a saúde não é uma receita de bolo né, você não sai com as dosagens tudo bonitinho que vai dar certo mas poderíamos trabalhar mais, investir isso mais nos alunos”

para que eles venham depois para o mercado de trabalho um pouco mais preparados.” (TD16)

Todos os participantes do estudo relataram espontaneamente sobre seus anseios e sentimentos frente ao tomada de decisão em situação de escassez de recursos, mesmo não interpelados sobre esta questão. Alguns enfatizaram que vivenciam sentimentos de pesar, impotência e insegurança.

“O que mais me pesa, o que mais fico chateada é de não poder fazer o melhor, você saber, ter uma bagagem, pede ajuda, lê nos livros, se capacita, mas você chega no local de serviço que não tem... não tem o que você fazer...” (TD19)

“Você fica insegura com receio de tá pensando se realmente você tomou a decisão certa (...) se a posição que você teve foi de forma adequada, então a gente sempre fica com esse receio, a gente tenta fazer o melhor mas não sabe se foi a melhor decisão tomada.” (TD03)

Os entrevistados expressaram também o desejo de abandono do serviço, angústia e conflitos pessoais em face do desgaste causado pela situação.

“Vivencio diariamente conflitos pessoais principalmente (risos) isso pra mim é um grande peso, eu já cheguei a abandonar algumas vezes (...) eu cheguei a pedir para sair da unidade porque eu não consegui lidar com essa seleção.” (TD10)

“Vou embora do plantão, às vezes passa, a gente brinca, passa a bomba mas eu vou embora pensando naquilo, é muito frustrante (...) eu sempre vou embora me sentindo muito mal e a angústia só aumenta.” (TD19)

Entretanto houve também profissionais que referiram tranquilidade, satisfação e sensação de dever cumprido nessa jornada, embora também tenha existido sentimento de culpa em momentos passados.

“Ah, eu fico tranquilo, mas assim, quando você tem essa decisão nesse sentido de ter em detrimento de um priorizar o outro, é ruim, né (...) eu não me sinto culpado por isso não... já me senti, a gente sente desconforto.” (TD05)

“É difícil, mas é bom, satisfatório também você vê que a sua tomada de decisão beneficiou o paciente.” (TD14)

“Eu nunca chego em casa e coloco a cabeça no travesseiro e penso assim podia ter feito mais, sabe, eu acho que eu sempre faço o que eu posso, o que tá no meu alcance dentro do que eu tenho.” (TD17)

As falas convergiram de modo geral para o desconforto sobre a situação vivida e desejo de que as decisões fossem até mesmo feitas por outros colegas de trabalho, gerando sensações de maior conforto e até mesmo de condescendência.

“tem hora que seria melhor a gente passar a responsabilidade pro outro, né... É muito ruim cê chegar pra uma pessoa e falar que cê não tem mais o que fazer, né (...) eu me sinto muitas vezes muito desconfortável, né, porque eu preferia que outra pessoa tivesse se responsabilizando por aquilo.” (TD07)

“Eu tomo as decisões mas não gosto, várias vezes eu converso com a equipe com quem tá comigo pra que não seja uma decisão única, não gosto de assumir sozinha alguns pontos não.” (TD10)

IV. DISCUSSÃO

Neste estudo, os entrevistados não expressaram auto-avaliações positivas quando relataram suas experiências no que concerne a tomada de decisão. A culpabilização e a preferência que outros decidam por eles, abrindo mão da tomada de decisão autônoma, foram marcantes nos depoimentos. A tomada de decisão em situação de recursos escassos parece resultar em conflitos éticos, levando a uma obrigação moral de disponibilizar recursos a qualquer custo. Este achado diverge do estudo realizado com médicos residentes na Catalunha em que os resultados demonstraram que estes profissionais avaliam positivamente suas experiências frente e tomada de decisão em serviços de urgência¹⁶.

Nesta perspectiva, a Bioética pode ser utilizada como um instrumento norteador por ser capaz de respaldar os envolvidos sobre os valores que prevalecerão na orientação e na justa tomada de decisão sobre as prioridades das necessidades de saúde a serem atendidas, bem como, aos limites a serem estabelecidos em situação de escassez de recursos¹⁷.

Cabe destacar a importância de a Bioética estar em consonância ao contexto em que está inserida de forma a melhor subsidiar as tomadas de decisão para os problemas sérios com relação à alocação de recursos no setor saúde¹⁸.

Surgem com o passar do tempo, formulações acerca da Bioética que melhor compreenderia as necessidades de países em desenvolvimento e que não estão exatamente relacionadas à Bioética proposta por *Beauchamp e Childress*¹⁸ que se pauta no principialismo, utilitarismo, autonomia e justiça. A realidade distinta desses países faz com que o enfoque seja diferente, imergindo a Bioética em um cenário de pobreza, desigualdade e exclusão social, o que evidencia a priorização de pessoas consideradas mais vulneráveis¹⁹.

Os participantes desta pesquisa, em sua maioria, referem à falta de conhecimento bioético desde a formação acadêmica, o que contribui para o estabelecimento de uma conexão frágil entre teoria e a prática profissional. A abordagem minimalista das

questões éticas tratadas no ambiente formativo não estimula a reflexão no campo moral, subjugando-a apenas à interpretação dos códigos de ética profissional²⁰. Apesar de na prática esperar-se tais responsabilidades, os entrevistados afirmaram que a academia não lhes preparou para esta tomada de decisão do ponto de vista ético.

Neste contexto, entendemos que se faz necessário um olhar sobre o ensino da bioética nos cursos de graduação da área da saúde que deve ser uma realidade e considerar a variedade de problemas que tem insurgido neste campo, tal qual como a necessidade de escolher pessoas para receber atendimentos em face da escassez de recursos.

Este paradoxo entre a dificuldade de entender e reconhecer a Bioética como instrumento para a tomada de decisão encontrada nesta pesquisa, corrobora com outros estudos que referem desconforto e dúvidas de tomadores de decisão sobre suas percepções no que diz respeito a questões de cunho moral e ético^{10-22; 23; 24}.

Quando relacionada à priorização de pacientes, a análise dos dados deste estudo nos permitiu confirmar que a tomada de decisão está ancorada em aspectos técnicos como gravidade, emergência, prognóstico, além, de julgamentos e dilemas morais dos atores envolvidos^{12,20}.

Os desafios da escolha passam também por considerar a probabilidade de resultados favoráveis e no contexto apresentado por este estudo, deve estar alicerçada na relação profissional-paciente. Ou seja, consideram a influência de outros atores que estão diretamente ou indiretamente envolvidos na situação, sejam eles os demais profissionais da equipe, a família e outras pessoas ligadas ao paciente^{25,20}.

A interpretação das narrativas permite entender que a tomada de decisão considera o compartilhamento de casos entre a equipe, passando pelo aconselhamento e orientações dos mais experientes e pelas discussões em conjunto. Não foi possível, contudo, identificar se o compartilhamento da decisão ocorre apenas por membros da mesma classe profissional ou de forma multiprofissional.

O compartilhamento de responsabilidades e a observância das considerações moralmente relevantes podem minimizar o sentimento de incerteza, já que nenhum princípio isolado é capaz de dar conta da priorização dos recursos da melhor forma possível^{10,20}.

O parâmetro idade foi apontado pelos participantes deste estudo como um critério aceito e utilizado para priorização de pacientes em situações de recursos escassos. Conclusões adversas foram obtidas por outro pesquisador, segundo estudo de Fortes¹⁷ realizado com bioeticistas, foi desfavorável ao racionamento de

cuidados de saúde baseado em critérios relativos à faixa etária. Entendemos ser pertinente mencionar e refletir sobre o fato de aceitar a idade como um critério de alocação de recursos em situação de escassez, posição essa discutível para ser considerada se levadas em conta às profundas modificações na estrutura etária das populações ocorridas desde o século XX.

A tomada de decisão como intrínseco a atuação profissional, muitas vezes ocorre em situações de conflitos, pois se trata de escolhas em situações de vulnerabilidade em meio a princípios divergentes²⁰. Concomitantemente, a ansiedade e sofrimento do paciente e da família são fatores que podem pressionar e fragilizar a prática da assistência, fato que reafirma a necessidade do substrato ético e moral para enfrentamento desta realidade²⁶.

Finalmente, alguns depoimentos evidenciaram a questão da existência de um número insuficiente de recursos humanos, que resulta em sobrecarga de trabalho; além da falta de materiais, que se traduz na necessidade de improvisos ou assistência inadequada. Fatores estes que contribuem para a insatisfação e desmotivação dos trabalhadores, além de fragilizar a prestação de serviços e a segurança do paciente. Vale destacar a ponderação de Oliveira²⁷ *et. al.* que concluiu que o conhecimento tácito, a experiência, os valores e as habilidades em desenvolver ações que priorizem a segurança do paciente constituem um tipo diferente de evidência, a qual tem uma forte influência na tomada de decisão.

Percebe-se nos discursos de alguns profissionais sentimentos de pesar, impotência e insegurança que requerem atenção no ambiente de trabalho, uma vez que podem contribuir para a exaustão e a despersonalização que passam a fazer parte da situação laboral nestes cenários. O impacto disso faz tornar as relações inviabilizadas e o trabalho como sem sentido na vida²⁸⁻³⁰.

Todavia, foram ainda evidenciados muitos discursos relativos à satisfação e sensação de dever cumprido frente à tomada de decisão na eminência de recursos escassos. Portanto, é de considerável relevância investir nestes profissionais, permitindo sua participação nos processos de análise permanente da tomada de decisão frente a recursos insuficientes, para continuarem identificando os riscos e incorporando práticas seguras e baseadas em evidência na instituição.

Considera-se a realização da investigação em uma única UPA, uma limitação deste estudo, pois pode não representar a realidade de outras unidades. Entretanto buscou-se aprofundar o significado que emergiu sobre a questão de pesquisa o que ratifica sua contribuição científica, frente à incipiência de outros estudos semelhantes.

V. CONSIDERAÇÕES FINAIS

Os resultados da pesquisa evidenciam que entre os profissionais pesquisados o pluralismo de valores morais é manifesto na questão da priorização ou estabelecimento de limites para utilização de recursos escassos no sistema público de saúde. Da diversidade de perspectivas e opiniões se pode inferir que as dificuldades do mundo contemporâneo em decidir moralmente sobre a questão parecem ser característica marcante de nossa época.

Dessa forma, é necessário investir em constantes diálogos, educação em saúde e estratégias de sensibilização de forma a contribuir para ações consensuais que melhor subsidiem a tomada de decisão em situação de recursos escassos e que favoreçam o cuidar em saúde equânime de forma a maximizar benefícios e reorientar processos de trabalho.

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REFERÊNCIAS

- [1] Brasil. Ministério do Planejamento. UPA - Unidade De Pronto Atendimento. [publicação online] [201-] Disponível em: <http://www.pac.gov.br/comunidade-cidada/upa-unidade-de-pronto-atendimento>.
- [2] Brasil. Ministério da Saúde. Núcleos de Economia da Saúde: orientações para implantação [publicação online]. Brasília; 2012 [cited 2017 Feb 07]. Disponível em: http://bvsms.saude.gov.br/bvs/publicacoes/gestao_economia_saude_v1_nucleos_implantacao.pdf
- [3] Kuate Defo B. Demographic, epidemiological, and health transitions: are they relevant to population health patterns in Africa? *Global Health Action* [periódico na Internet] 2014 [acessado 2017 Ago 3];7(10). Disponível em: <http://www.tandfonline.com/doi/full/10.3402/gha.v7.22443>
- [4] Brasil. Ministério da Saúde. Portaria nº 1.600, de 7 de julho de 2011. Reformula a Política Nacional de Atenção às Urgências e institui a Rede de Atenção às Urgências no Sistema Único de Saúde (SUS). Brasília, DF, 07 jul 2011. Disponível em: http://bvsms.saude.gov.br/bvs/saudelegis/gm/2011/prt1600_07_07_2011.html
- [5] Brasil. Ministério da Saúde. Sem Título. [publicação online]. Brasília; 2014 [acessado 2017 Fev 07]. Disponível em: <http://portalsaude.saude.gov.br/index.php/o-ministerio/principal/secretarias/454-sas-raiz/dab/upa/11-upa/9667-documento-prioritario>.
- [6] Brasil. Conselho Nacional de Secretários de Saúde. A Atenção Primária e as Redes de Atenção à Saúde. [publicação online]. Brasília; 2015 [acessado 2017 mar 03]. Disponível em: <http://www.conass.org.br/biblioteca/pdf/A-Atencao-Primaria-e-as-Redes-de-Atencao-a-Saude.pdf>
- [7] Erdmann AL, Andrade SR, Mello ALSF, Drago LC. Secondary Health Care: best practices in the health services network. *Rev Latino-Am Enfermagem* [periódico na Internet] 2013 Fev [acessado 2017 Jun 5]; 21(spe). Disponível em: <http://www.scielo.br/pdf/rlae/v21nspe/17.pdf>
- [8] Konder MT, O'Dwyer G. As Unidades de Pronto-Atendimento na Política Nacional de Atenção às Urgências. *Physis* [periódico na Internet] 2015 Jun [acessado 2017 Ago 07];25(2). Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-73312015000200525&lng=pt.
- [9] Silva KR, Mello DS. Recursos Escassos em Serviços de Urgência e Emergência e a Tomada de Decisão: Revisão bibliográfica. Simpósio Direito e Saúde – Diálogos Interdisciplinares Latinoamericanos; 2015; Santiago, Chile.
- [10] Vasconcellos MM. *A necessidade de priorizar o atendimento à pacientes: análise Bioética dos argumentos utilizados por médicos na aplicação de recursos limitados na área da saúde*. [dissertação]. Rio de Janeiro: Escola Nacional de Saúde Pública Sérgio Arouca/ Fundação Oswaldo Cruz, 2010.
- [11] Rocha RO. *Bioética e Alocação de Recursos em Saúde: Reflexões sobre o Compartilhamento Democrático das Tecnologias Médicas Avançadas*. [dissertação]. Salvador: Universidade Federal da Bahia; 2013.
- [12] Freitas EEC, Schramm FR. A moralidade da alocação de recursos no cuidado de idosos no centro de tratamento intensivo. *Rev Bras Ter Intensiva* [periódico na Internet] 2009 [acessado 2017 Mar 03] 21(4). Disponível em: <http://www.rbti.org.br/exportar-pdf/v21n4a14.pdf>
- [13] Silva KR, Mello DS, Ribeiro RM, Roquete FF. Tomada de Decisão em Situação de Recursos Escassos: uma discussão bioética. *Simpósio de Excelência em Gestão e Tecnologia*; 2015; Resende, Rio de Janeiro.
- [14] Reis AAC, Sóter APM, Furtado LAC, Pereira SSS. Everything to fear: funding, public-private relations, and the future of SUS. *Saúde debate* [periódico na Internet] 2016 Dez [acessado 2017 Ago 31] 40(spe). Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-11042016000500122&lng=en.
- [15] Muylaert CJ, Sarubbi Jr V, Gallo PR, Rolim Neto ML, Reis AOA. Narrative interviews: an important resource in qualitative research. *Rev. esc. enferm. USP* [periódico na

- Internet]. 2014 Dez [acessado 2017 Fev 01]; 48(spe2). Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0080-62342014000800184&lng=en.
- [16] Coll-Vinent B, Carreño A, Morales X, Cerón A, Gutiérrez EC, Surís X. Opinión de los médicos residentes de los hospitales catalanes sobre la formación en urgencias. *Emergencias* [periódico na Internet] 2015 [acessado 2017 Jun 5]; 27(4). Disponível em: http://emergencias.portalsemes.org/descargar/opinin-de-los-mdicos-residentes-de-los-hospitales-catalanes-sobre-la-formacin-en-urgencias/force_download/
- [17] Fortes PAC. Bioeticistas e a priorização de recursos de saúde no sistema público de saúde brasileiro. *Revista Bioética* [periódico na Internet] 2010 [acessado 2017 Mar 04]; 18(2). Disponível em: http://revistabioetica.cfm.org.br/index.php/revista_bioetica/article/download/573/545
- [18] Beauchamp T L, Childress, J F. *Princípios de Ética Biomédica*. São Paulo: Loyola, 2002.
- [19] Pessini L, Barchifontaine CP. *Problemas atuais de bioética*. 8. ed. São Paulo: Loyola, 2007.
- [20] Oliveira SCGF. *Protocolos e diretrizes clínicas: Uma análise moral na tomada de decisão* [dissertação]. Rio de Janeiro: Escola Nacional de Saúde Pública - Fundação Oswaldo Cruz; 2014.
- [21] Leite DAA, Pessalacia JDR, Braga PP, Rates CMP, Azevedo C, Zoboli ELCP. Uso de la casuística en el proceso de enseñanza-aprendizaje de bioética en la salud. *Revista Bioética* [periódico na Internet] 2017 [acessado 2017 Set 04]; 25(1). Disponível em: http://revistabioetica.cfm.org.br/index.php/revista_bioetica/article/viewFile/1032/1604
- [22] Belli L, Boden MT, Quadrelli S, Somers ME ¿Qué hacer cuando no sabemos qué hacer? *Revista Americana de Medicina Respiratoria* [periódico na Internet] 2015 [acessado 2017 Mar 04]; 15(4). Disponível em: <http://www.redalyc.org/pdf/3821/382143170011.pdf>
- [23] Saraiva AMP. Acesso à tecnologia biomédica: perspectiva bioética dos enfermeiros portugueses. *Revista Bioética* [periódico na Internet] 2014 [acessado 2017 mar 04]; 22(1). Disponível em: <http://www.scielo.br/pdf/bioet/v22n1/a18v22n1.pdf>
- [24] Abreu CBB. *Questões éticas reconhecidas por profissionais de uma equipe de Cuidados Paliativos*. [tese]. São Paulo: Faculdade de Saúde Pública- Universidade de São Paulo; 2014.
- [25] Montezeli J, Peres A, Bernardino E. Nurse Management Skills Required At An Emergency Care Unit. *J res: fundam care online* [periódico na Internet] 2013 Mai [acessado 2017 Sep 7];5(3). Disponível em: <http://www.seer.unirio.br/index.php/cuidadofundamental/article/view/2019>
- López-Martín S, Galera-Martin C, Guerra-Tapia A. Ethics in Dermatology: Toward a New Paradigm. *Actas Dermosifiliogr* [periódico na Internet] 2013 [acessado 2017 Sep 28];104(6). Disponível em: <http://www.actasdermo.org/en/dermatologia-etica-el-nuevo-paradigma/articulo/S1578219013001170/>
- [26] Oliveira RM, Leitão IMTA, Silva LMS, Figueiredo SV, Sampaio RL, Gondim MM. Estratégias para promover segurança do paciente: da identificação dos riscos às práticas baseadas em evidências. *Escola Anna Nery Revista de Enfermagem* 18(1) Jan-Mar 2014. Disponível em: <http://www.scielo.br/pdf/ean/v18n1/1414-8145-ean-18-01-0122.pdf>
- [27] Ribeiro CDM, Rego S. Bioética clínica: contribuições para a tomada de decisões em unidades de terapia intensiva neonatais. *Ciência & Saúde Coletiva* [periódico na Internet] 2008 [acessado 2017 mar 04];13(spe) Disponível em: http://www.scielo.br/scielo.php?pid=S1413-81232008000900028&script=sci_abstract
- [28] Oliveira EB, Pinel JS, Gonçalves JBA, Diniz DB. Nursing work in hospital emergency units – psychosocial risks: a descriptive study. *Online braz j nurs* [periódico na Internet] 2013 Mar [acessado 2017 Sept 7];12(1). Disponível em: <http://www.objnursing.uff.br/index.php/nursing/article/view/4046>.
- [29] Batista JBV, Carlotto MS, Oliveira MN, Zaccara AAL; Barros EO, Duarte MSC. Transtornos mentais em professores universitários: estudo em um serviço de perícia médica. *Rev. pesqui. cuid. fundam.*, [periódico na Internet] 2016 [acessado 2017 Sep 28];8(2). Disponível em: http://www.seer.unirio.br/index.php/cuidadofundamental/article/download/5009/pdf_1914
- [30] Casarolli ACG, Eberhardt TD, Nicola AL, Fernandes LM. Nível de complexidade assistencial e dimensionamento de enfermagem no Pronto-Socorro de um hospital público. *Revista de Enfermagem da UFSM* [periódico na Internet] 2015 Jul [acessado 2017 Jun 15]; 5(2). Disponível em: <https://periodicos.ufsm.br/reufsm/article/view/16811>

Uma aplicação colaborativa de incentivo a doação de sangue

A collaborative application to encourage blood donation

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Abstract— Objective: Implementing a collaborative system that promotes the encouragement and support of blood donation. Permitting specific patient blood donation requests, disseminating general outreach campaigns, reviewing site information for donation, as well as keeping users up-to-date on blood stock levels of blood centers and disclose the procedures necessary to become donor blood. **Method:** A qualitative survey was carried out of the main tools with possible related proposals to serve the region of Cajazeiras, Paraíba, Brazil. **Results:** It was identified the existence of possible tools to encompass the region of the study using them to know the needs and definition of the scope of the collaborative system proposing new approaches in the development for implantation in the Hemonúcleo of the city of Cajazeiras. **Conclusion:** The development of the collaborative system contemplated a series of functionalities to join blood centers and candidates to blood donation to better maintain the life of several patients.

Keywords— Blood donation; Collaborative system; Blood centers.

Resumo— Objetivo: Implementar um sistema colaborativo que promova o incentivo e apoio a doação de sangue. Permitindo realizar pedidos de doação de sangue para paciente específico, divulgar campanhas de abrangência geral, consultar informações de locais para doação, assim como, manter os usuários atualizados sobre os níveis de estoques de sangue dos hemocentros e divulgar os procedimentos necessários para se tornar doador de sangue. **Método:** Foi realizado um levantamento qualitativo das principais ferramentas com propostas relacionadas possíveis de atender a região de Cajazeiras, Paraíba, Brasil. **Resultados:** Identificou-se a existência de ferramentas possíveis de atender a região do estudo utilizando-as para conhecer as necessidades e definição do escopo do sistema colaborativo propondo novas abordagens no desenvolvimento para implantação no Hemonúcleo da cidade de Cajazeiras. **Conclusão:** O desenvolvimento do sistema colaborativo contemplou uma série de funcionalidades para unir hemocentros e candidatos à doação de sangue para melhor manutenção da vida de inúmeros pacientes.

Descritores— Doação de Sangue; Sistema colaborativo; Hemocentros.

I. INTRODUÇÃO

No Brasil cerca de 3,5 milhões de pessoas necessitam da realização de transfusão de sangue por ano⁽¹⁾. Diante disso, é importante traçar mecanismos voltados à prevenção da vida de inúmeros pacientes que dependem de transfusão de sangue por meio da manutenção dos estoques sanguíneos.

Sendo assim, os hemocentros se deparam com a necessidade de adotar medidas que influenciem novos doadores a se prontificarem espontaneamente para doação de sangue, uma vez que a Constituição Federal de 1988, vigente atualmente, em seu §4º do Art. 199 que discorre sobre a coleta, processamento, estocagem, distribuição e aplicação do sangue, coloca em estado de proibição qualquer tipo de comercialização do sangue e seus hemoderivados⁽²⁾.

Mediante o estado de proibição, o governo aplica e disponibiliza recursos para a realização de campanhas de utilidade pública, visando à manutenção e o abastecimento dos estoques sanguíneos que, tais recursos proporcionaram um gasto de R\$ 85,4 milhões de todo o orçamento para publicidades do Governo Federal em 2015⁽³⁾.

Os resultados destes gastos deveriam ser colhidos sucessivamente nos anos seguintes, construindo uma conscientização para surgirem sempre novas doações. No entanto, de acordo com os resultados dos dados coletados nos anos de 2016 e 2017 e divulgados no Dia Mundial do Doador de Sangue, celebrado em 14 de junho de 2017, no Hemocentro de Brasília (FHB)⁽⁴⁾, o percentual de doadores de 1,8% da população brasileira, mesmo estando dentro do indicado pela Organização Mundial da Saúde (OMS) ainda não era o ideal para o Brasil⁽¹⁾. O indicado é que a taxa de doações de sangue sempre caminhe afrente das necessidades de transfusões sanguíneas, já que o sangue e hemoderivados são fundamentais para a permanência da vida de pacientes. Para que ocorram melhorias e esse processo não se inverta é de extrema importância acolher iniciativas que visem atrair novos doadores, levando ao conhecimento de todos aqueles com condições favoráveis a importância de doar sangue.

A aplicação desenvolvida neste estudo permite compartilhar as motivações para se tornar doador de sangue por meio de pedidos de doação para pacientes específicos e de campanhas de abrangência geral. Permite também, consultar informações sobre os locais onde possa realizar doação de sangue e melhor se informar sobre o passo-a-passo de triagem e coleta do sangue, assim como, manter-se atualizado e informado sobre os níveis dos estoques sanguíneos em dado hemocentro/hemonúcleo. Além disso, recolher informações dos candidatos à doação, e disponibilizar para os administradores do hemocentro/hemonúcleo um mapa para auxiliar a tomada de decisões na elaboração das campanhas de cativação de novos doadores, conforme a necessidade sanguínea.

A aplicação pode ser utilizada para, por exemplo, a partir dos níveis de estoques de determinado tipo sanguíneo estarem baixo saber em quais regiões de uma cidade se concentra mais candidatos à doação de sangue do tipo necessário, ajudando assim, na aplicação e implementação da Política Nacional de Promoção da Doação Voluntária de Sangue principalmente na região de Cajazeiras, Paraíba, Brasil.

II. MÉTODOS

A realização do trabalho iniciou-se por meio de um estudo para analisar os critérios definidos pela legislação brasileira possível de serem utilizados para atrair candidatos para realização de novas doações de sangue. Conduziu-se também um estudo qualitativo com o propósito de relacionar os sistemas com propostas parecidas possíveis de serem utilizados na região de Cajazeiras do estado da Paraíba, para assim entender a viabilidade do desenvolvimento do sistema colaborativo deste trabalho, definindo o escopo e propondo novas funcionalidades.

Adotando a metodologia ágil *Scrum* como abordagem para o gerenciamento do projeto do *software* dividiu-se a realização do sistema, seguindo um fluxo das seguintes etapas:

- a) Conceituação da solução proposta: que visou entender as problemáticas e as possíveis soluções;
- b) Levantamento de requisitos: que possibilitou listar os requisitos com a finalidade de documentar todas as funcionalidades;
- c) Visão geral dos requisitos: em que foi feita um modelagem que ajuda na comunicação e interpretação dos requisitos;
- d) Projetos arquiteturais do sistema e aplicativo: definição da arquitetura, a separação em camadas e tecnologias a serem utilizadas para o desenvolvimento;
- e) Implementação das funcionalidades: desenvolvimento em si do sistema colaborativo (Mútuo Sanguíneo);
- f) Versionamento e validação: separação das implementações dos requisitos levantados, validada cada etapa junto ao Hemonúcleo da cidade de Cajazeiras no estado da Paraíba.
- g) Comparativo com ferramentas existentes.

Para validação das implementações das funcionalidades foi elaborado um questionário de aceitação, possibilitando aos interessados no desenvolvimento do sistema indicar o nível de satisfação quanto às funcionalidades implementadas e confirmar o posicionamento para cada implementação quanto ao grau atendimento se Excelente, Bom, Regular, Ruim ou Péssima.

III. RESULTADOS E DISCUSSÃO

Proporcionar um ambiente colaborativo, dotado das condições necessárias, que leve os candidatos a se decidirem voluntariamente a realizarem doações de sangue, não é tão simples. Para Massuchetto apud Maxim⁽⁵⁾ a tomada de decisão é uma habilidade complexa, mas que pode ser desenvolvida por meio de assistência e orientação.

Pensando assim, existem sistemas computacionais que conseguem fornecer informações fundamentais para tomada de decisões. Os *softwares* colaborativos de apoio coletivo à tomada de decisão é exemplo disso. Esta é uma classe de sistemas usados para ajudar às pessoas no exercício de atividades e trabalhos em conjuntos⁽⁶⁾. A abordagem deste autor caminha em encontro a etimologia do termo colaboração, que conforme Rios et al.⁽⁷⁾ (apud HOUAISS; VILLAR, 2009) significa trabalhar em comum acordo, ou seja, em coordenação harmônica de ações, diferentemente da cooperação que é trabalhar com outros sem a existência do consenso.

Para Rios et al.⁽⁷⁾ (apud FUKS et al., 2011) os sistemas colaborativos devem permitir a comunicação sem a dependência de tempo e espaço proporcionando condições para que grupos com objetivos comuns possam interagir.

Desta forma, Rios et al.⁽⁷⁾ (apud FUKS et al., 2011 apud ELLIS, et al., 1991) apresentam o modelo 3C, baseando-se na concepção de que para os membros de um grupo colaborarem se faz necessário:

- a) Comunicação: suporte a integração fácil e rápida dos grupos, pelo recebimento e envio de informações solicitações e instruções;
- b) Coordenação: permite uma sequência de tarefas de forma a buscarem um objetivo comum;
- c) Cooperação: proporcionando a realização do trabalho em conjunto, possibilitando unir experiências e habilidades.

Neste sentido temos a construção do Mútuo Sanguíneo pautando-se na visão dos processos decisórios e na análise das informações fornecidas de forma colaborativa pelos usuários para proporcionar apoio aos hemocentros/hemnúcleos na identificação das necessidades de trabalhar campanhas e ações na implantação da política de incentivo e apoio a doação de sangue. E com isso auxiliar no exercício de atrair novos candidatos para a prática da doação de sangue.

O desenvolvimento de *software* precisa ser apoiado na qualidade. A qualidade é um item preponderante para o sucesso de um software, estando ela ligada ao atendimento dos requisitos⁽⁸⁾. Para a construção de um sistema com foco na qualidade se faz necessário à adoção de metodologias, ou seja, fazer uso de abordagens tidas como práticas já firmadas no desenvolvimento de *software*⁽⁸⁾. Sendo assim, o processo de desenvolvimento *Scrum* foi usado para gerenciar o projeto de *software*, adequando-o ao contexto do sistema colaborativo o qual este trabalho está inserido.

O *Scrum* é uma metodologia ágil usada para gerenciar o desenvolvimento de projetos complexos desde o início de 1990 que tem como prerrogativa não resultar de um processo ou uma técnica rígida e definitiva para construção de produtos, mas sim, ser uma estrutura dentro da qual cada um pode empregar vários processos ou técnicas⁽⁹⁾. Essa metodologia enfatiza o uso de um conjunto de padrões de processos de *software* que provaram serem eficazes para projetos com prazos de entrega apertados, requisitos mutáveis e críticos de negócio⁽⁸⁾.

Nesta perspectiva, foi feita uma lista das obrigatoriedades levando em consideração as prioridades dos interessados no sistema, postas para serem trabalhadas. Na implementação das funcionalidades preocupou-se sempre com questões como: sincronia no desenvolvimento e adequação das propostas em relação a mudanças de requisitos, quando necessário, para melhoria na identificação de possíveis impedimentos no desenrolar da construção das funcionalidades.

Para estabelecer uma melhor compreensão o diagrama de caso de uso da Fig.1 apresenta uma visão geral das funcionalidades levantadas a serem distribuídas para os dois tipos de atores envolvidos na utilização do sistema. O caso de uso é uma abordagem da *Unified Modeling Language* (UML) em forma de diagramas que fornece uma visão dos requisitos do sistema na perspectiva do usuário⁽¹⁰⁾. Desta forma cada caso de uso define um conjunto de funcionalidades a serem implementados no sistema.

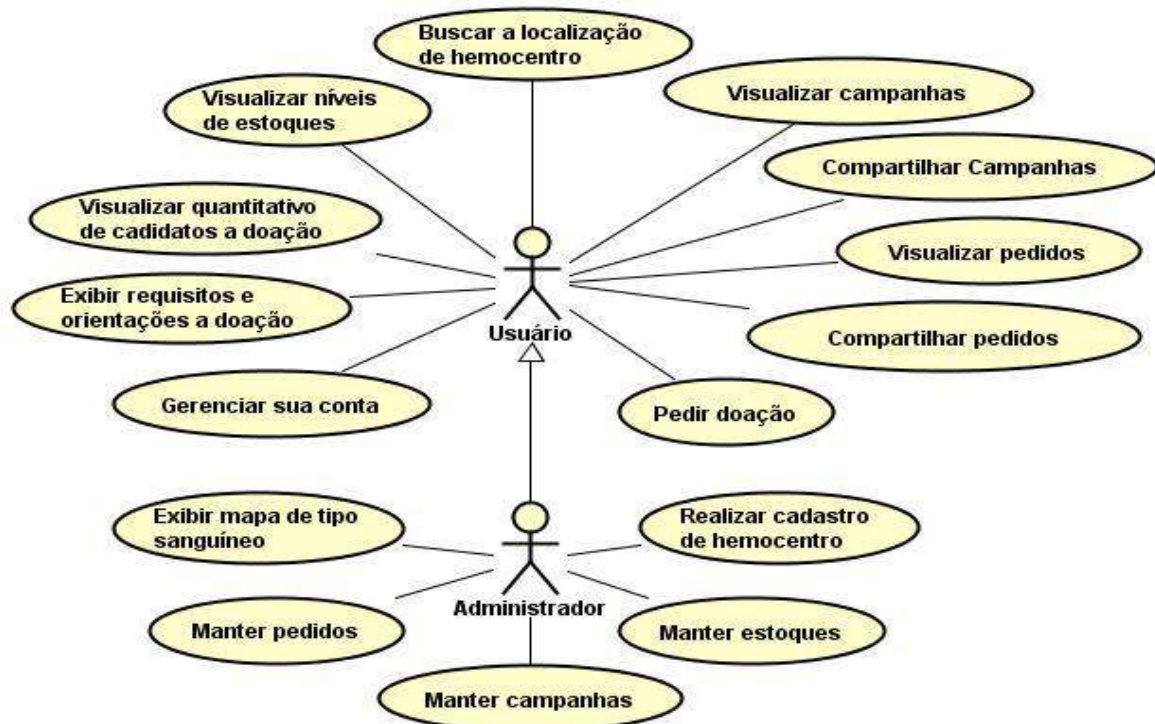


Fig.1– Visão geral das funcionalidades do sistema

Os requisitos levantados descrevem as funcionalidades da aplicação. Cada requisito foi detalhado à medida que novas funcionalidades eram adicionadas possibilitando planejar cada passo a ser seguido para adição de novas funcionalidades no sistema e o versionamento das implementações das funcionalidades do sistema. Os requisitos funcionais do sistema estão listados na Tabela 1em que se tem uma divisão em módulo do usuário e do administrador seguido da ordenação e de uma descrição dos requisitos levantados juntos aos interessados no desenvolvimento do sistema.

Tabela 1– Levantamento de requisitos funcionais para a aplicação Web e Mobile.

MÓDULO USUÁRIO	
Requisitos	Descrição
RF1	Cadastro do usuário no sistema.
RF2	Exibir requisitos e orientações para doação.
RF3	Visualizar quantitativos de candidatos à doação.
RF4	Visualizar níveis de estoques de sangue do hemocentro/hemonúcleo.
RF5	Buscar a localização de hemocentros.
RF6	Visualizar campanhas.
RF7	Compartilhar campanhas.
RF8	Visualizar pedidos de doações.
RF9	Compartilhar pedidos de doações.
RF10	Realizar pedido de doações.
MÓDULO ADMINISTRADOR	
RF11	Gerenciar usuário.
RF12	Manter cadastro de hemocentros.
RF13	Manter informações de estoques de coleta do hemocentro.
RF14	Manter campanhas de coleta de sangue.
RF15	Manter pedidos de doação de sangue.
RF16	Exibir mapa de tipo sanguíneo e fator RH (Grupo Sanguíneo).

Legenda: RF – Requisito Funcional; 1 a 16 – Enumeração.

Foi projetada a implantação do sistema para ser executado em um servidor de aplicação na rede mundial de computadores principalmente para ser utilizado pelo administrador e assim, prover recursos para a aplicação *Mobile*. Desta forma para acessar as principais funcionalidades disponibilizadas do sistema, os usuários necessitam de acesso à *Internet*, fazer uso de um navegador (*browser*) e em casos de funcionalidades restritas de realizar a adequada autenticação na aplicação.

3.1 APLICAÇÃO DE SERVIÇOS WEB

Foi essencial traçar uma independência dos códigos, e assim, organizou-se o sistema em camadas seguindo o *Model View Control (MVC)*⁽¹¹⁾ para através da aplicação *Mobile* ser possível acessar recursos providos pela a aplicação de serviços *Web* por meio da disponibilização de recursos da *Application Programming Interface (API)*. Desta maneira, isolando as regras de negócios das suas principais interfaces gráficas, atentando para aspectos de segurança e proporcionando uma separação entre os componentes das camadas.

Todo o projeto do servidor de serviços *Web* seguiu princípios da orientação a objetos em que foi utilizado principalmente abordagem da linguagem de programação *Java™*⁽¹²⁾ para o desenvolvimento da aplicação e disponibilização de serviços *Web (Webservices)*. Entretanto, em apoio a esta linguagem foram utilizadas outras tecnologias, usufruindo sempre o que de melhor tenham a oferecer, em cada camada, para promover uma boa experiência aos usuários da aplicação.

A Fig.2a apresenta as camadas e as principais tecnologias e recursos utilizados na implementação do sistema seguindo a abordagem de múltiplas camadas para melhor dividir as responsabilidades.

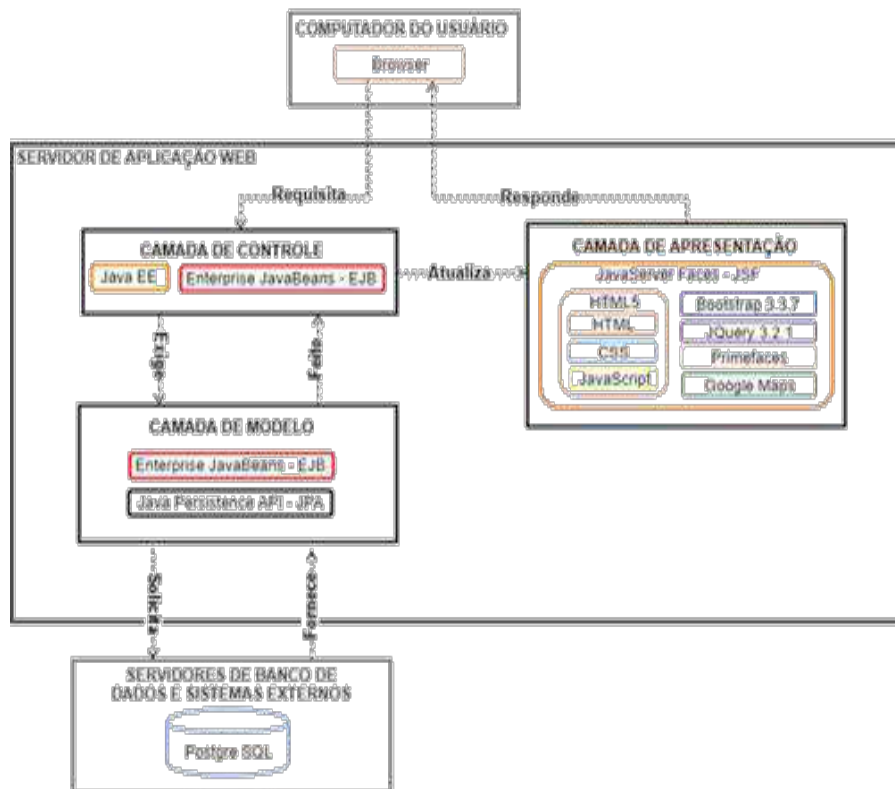


Fig.2– Visão geral das tecnologias usadas nas camadas do sistema de serviços Web

Esta abordagem de múltiplas camadas permite a inserção de mais recursos e/ou criação de interfaces ou até mesmo novas camadas, sem alterar o código do modelo de negócio, permitindo trabalhar em recursos de uma determinada camada sem a problemática direta de fragilizar as demais e com isso, potencializando a manutenibilidade sem perdas na realização das operações do sistema.

3.1.1 Camada de apresentação

A camada de apresentação fornece aos usuários da aplicação a possibilidade de interação com as funcionalidades e recursos disponibilizados pelo MútuoSanguíneo. Os usuários por meio do uso de *Browser* (navegadores *Web*) podem interpretar os recursos estáticos, dinâmicos, entre outros, utilizados para construção das páginas do sistema.

A camada de apresentação recebe atualizações das informações referentes às requisições feitas pelos navegadores à camada de controle, e assim, interagindo dinamicamente com os usuários, mostrando nas páginas do sistema, tais informações, conseqüentemente a serem apreciadas pelos interessados.

Objetivando alcançar tal dinamicidade foram utilizadas versões mais recentes da especificação JavaServer Faces (JSF)¹ integrada a JEE e gerenciado por um servidor de aplicação. Usou-se o PrimeFaces² apropriando-se da sua principal característica de biblioteca de interface gráfica para interagir com o projeto JSF.

Também foi adotado preceitos do HTML5 abrangendo o HTML propriamente dito, o CSS e o JavaScript. O CSS em conjunto com o *framework* Bootstrap³ para proporcionar uma amigável visão das páginas e o JavaScript em conjunto com o *framework* JQuery⁴ para manipulação de dados principalmente vindos do Google Maps⁵.

3.1.2 Camada de controle

A camada de controle proporciona a relação com os artefatos da camada de apresentação e a camada de modelo, estabelecendo a relação entre cada recurso a serem consumidos e/ou usados. Esta camada se responsabiliza por receber as requisições dos navegadores *Web* e exigir da camada de modelo a realização da requisição, como também receber a resposta da camada de modelo e atualizar a camada de apresentação proporcionando aos usuários apreciarem as respostas para a solicitação.

Para realização da intermediação, a camada de controle foi construída basicamente por recursos e abordagem do EJB associada a JEE, possibilitando receber as requisições dos navegadores, acessando os dados oferecidos pela camada de modelo, e assim, realizar as interações necessárias entre visões do sistema para controlar como esses dados são apresentados.

3.1.2 Camada de modelo

A camada de modelo fornece a interação entre todas as regras de negócios do sistema, por meio de investidas que proporcionem constância e permanência das informações fazendo uso dos instrumentos de persistências das informações.

Para manter as informações se faz necessário a construção de componentes distribuídos, proporcionando transações e portabilidade por meio dos componentes do JEE como do EJB. Além disso, para interação com os servidores de banco de dados, usou-se abordagem do provedor do Java Persistence API (JPA)⁶, visando a persistência dos dados e a validação das entidades.

Na perspectiva da permanência dos dados, foi tido como base para construção da persistência definições do PostgreSQL⁷, através das especificações JPA, possibilitando a verificação e validação dos dados a serem constantemente analisados no uso do MútuoSanguíneo.

3.2 APLICAÇÃO MOBILE

O aplicativo *Mobile* também foi projetado seguindo a abordagem de múltiplas camadas para melhor dividir as responsabilidades da aplicação. A Figura 3 apresenta as camadas e as principais tecnologias e recursos utilizados na implementação da parte *Mobile*.

¹<http://www.oracle.com/technetwork/java/javaee/javaserverfaces-139869.html>

²<https://www.primefaces.org/>

³<https://getbootstrap.com/>

⁴<https://jquery.com/>

⁵<https://developers.google.com/maps/?hl=pt-br>

⁶<http://www.oracle.com/technetwork/java/javaee/tech/persistence-jsp-140049.html>

⁷<https://www.postgresql.org/>

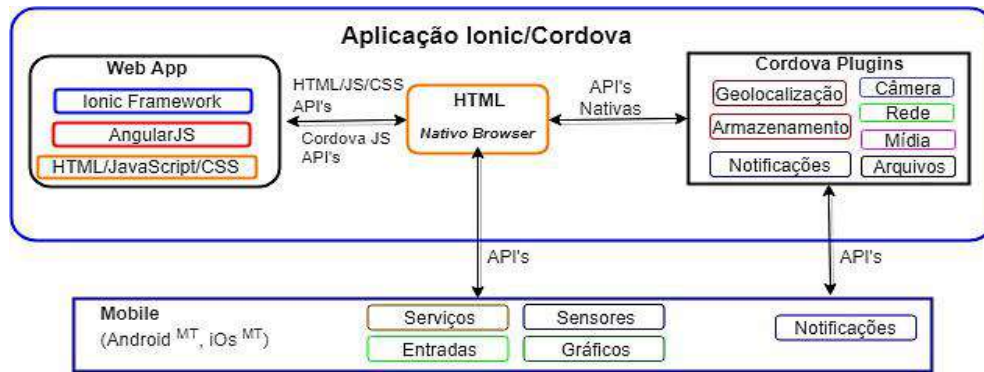


Fig.3 – Visão das tecnologias usadas para construção do aplicativo Mobile

Fazendo uso do IONIC framework⁸, o qual proporciona diversas bibliotecas de Cascading Style Sheets (CSS) e JavaScript para AngularJS⁹, foi possível simplificar o trabalho de desenvolvimento necessitando de conhecimento, apenas de HTML, CSS, JavaScript. Como também, usando o Cordova¹⁰ para encapsular o código feito com IONIC foi possível compilar para formatos a serem instalados nos principais sistemas operacionais do mercado (Android^{MT}, iOS^{MT}).

3.3 IMPLEMENTAÇÃO

Como resultado deste trabalho foi desenvolvido um sistema Web que prover serviços e um aplicativo Mobile colaborativo (MútuoSanguíneo) para contribuir no processo de doação de sangue. Além da disseminação das necessidades de doação sanguínea, o sistema também tem como proposta tornar mais acessíveis informações pertinentes para candidatos à doação de sangue. Auxiliando na aplicação da Política Nacional de Promoção da Doação Voluntária de Sangue disponibilizando um ambiente mútuo aos usuários do sistema possibilitando difundirem as motivações e razões para se tornar doador, contribuírem para propagar as orientações, os critérios, as campanhas e os pedidos para aqueles que necessitam de doação de sangue.

Tomando como ponto de partida o levantamento de requisitos da aplicação, temos as implementações das funcionalidades do MútuoSanguíneo como as principais para o entendimento do sistema Web e do aplicativo Mobile. Exibir requisitos e orientação para doação às orientações aos candidatos à doação de sangue conforme apresenta a Fig.3 possibilita conhecer os principais critérios, orientações e impedimentos para realizar a doação de sangue.

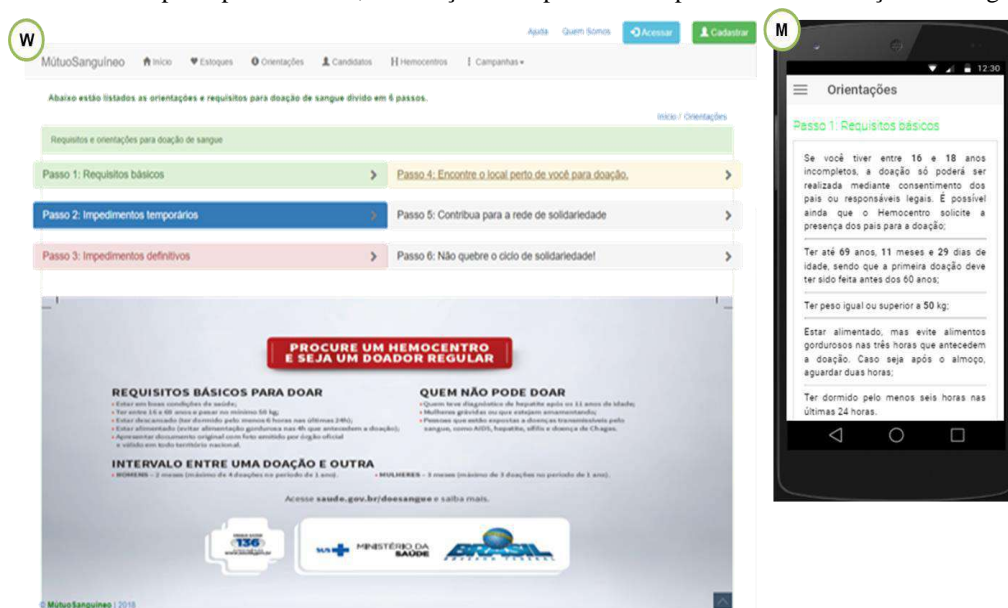


Fig.3– Página Web e Mobile de requisitos e orientações para doação (RF2)

⁸<https://ionicframework.com/>

⁹<https://angularjs.org/>

¹⁰<https://cordova.apache.org/>

Visualizar níveis de estoques do hemocentro/hemonúcleo, ou seja, níveis de estoques de coletas de sangue do hemocentro/hemonúcleo é também um importante requisito para a cativação de novos doadores. Condizente com a realidade de cada hemocentro/hemonúcleo é o ponto principal para que novas campanhas sejam trabalhadas, visando a manutenibilidade dos níveis dos bancos de coletas. Conforme apresenta a Fig.4 com uma exibição por tipo sanguíneo para dado hemocentro/hemonúcleo pesquisado, o propósito primordial desta funcionalidade é com este levantamento ser possível a percepção de quais tipos sanguíneos estão em baixa, precisando de novas doações.

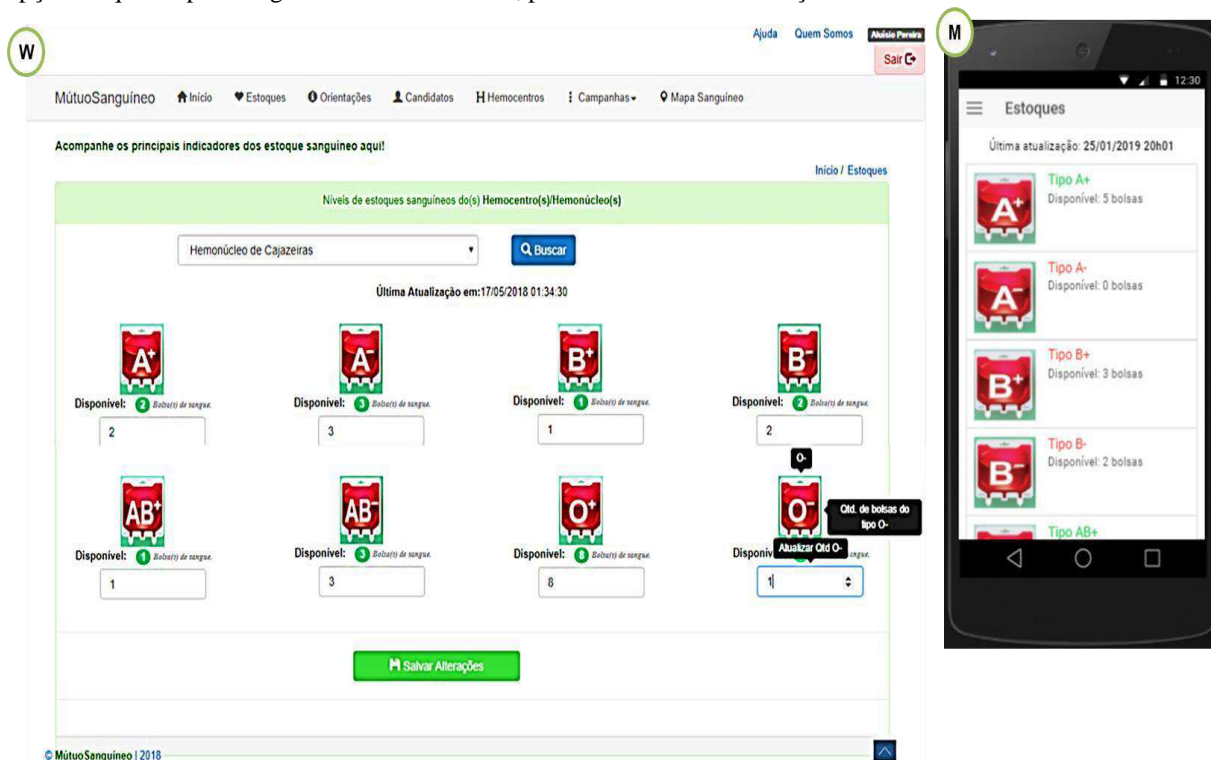


Fig.4- Página Web e Mobile de níveis de estoques do hemocentro/hemonúcleo (RF4 e RF13)

Buscar a localização de hemocentros cadastrados no sistema visa assessorar os candidatos à doação de sangue a identificarem os locais apropriados para o exercício da prática. Para a construção deste requisito se fez necessário seguir as especificações do *Google Places API*¹¹, tendo com isso uma associação dos dados no mapa à real localização da unidade de coleta cadastrada.

Os usuários administradores podem por meio da funcionalidade de gerenciar usuários, manter os usuários do sistema possibilitando aos mesmos ao acessarem a página de candidatos à doação, conforme Fig.5, optar por visualizar informações dos usuários, atualizar informações de cadastro, assim como excluir usuários do sistema.

Caso opte por editar os dados do usuário o administrador será direcionado para um ambiente para realização da edição dos dados do usuário cadastrado. Porém caso opte por excluir o usuário, ao administrador apresentado à devida confirmação de exclusão do usuário e mediante confirmação afirmativa o usuário é excluído da base de dados.

¹¹<https://developers.google.com/places/?hl=pt-br>

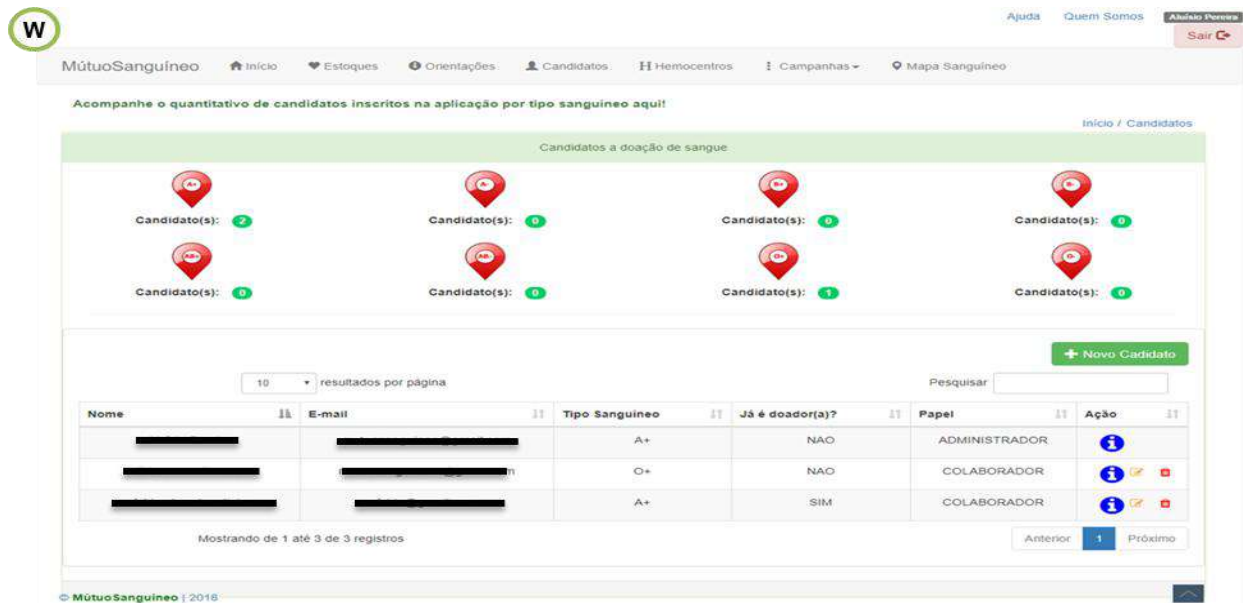


Fig.5– Tela Web de gerenciamento de usuários

Já se o administrador optar por visualizar informações do usuário o administrador será redirecionado para uma página em que poderá contemplar mais informações do usuário podendo assim, exibir as informações cadastradas para cada usuário requisitado, como também ver informações da localização fornecida pelo usuário em mapa. O sistema busca na base de dados às informações referentes ao usuário e apresenta conforme apresenta a Fig.6.

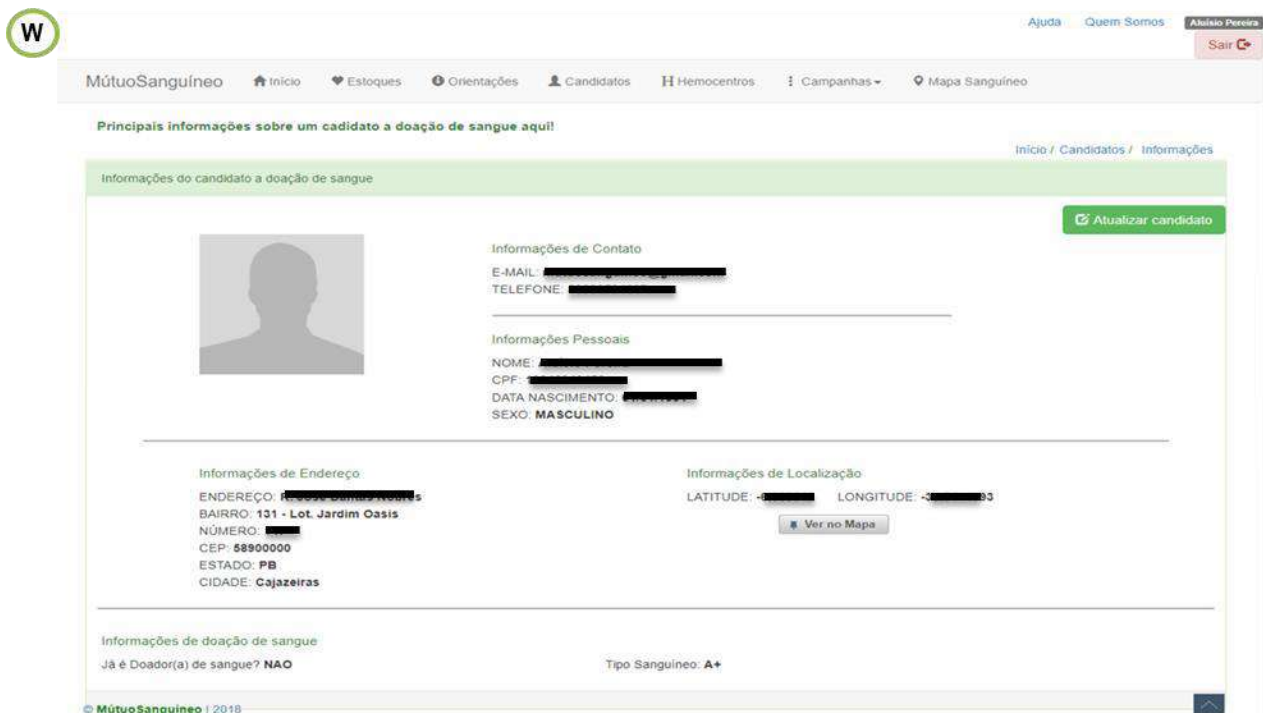


Fig.6– Tela Web para visualização do usuário

Para melhor entender, a Fig.7, apresenta a página com uma lista dos hemocentros/hemonúcleos cadastrados no sistema. As informações apresentadas ao usuário são referentes a cada instituição de coleta, exibindo o nome, o endereço, o estado e a cidade de localização, o tipo de atividade que a instituição tem capacidade de realizar e o telefone da instituição.

Como também ao clicar no botão com texto “Localização no Mapa” referente a um hemocentro/hemonúcleo, o sistema apresenta uma visualização da localização da instituição de coleta no mapa conforme a Fig.8. Para isso, tanto o

o sistema Web como o aplicativo realiza uma busca na base de dados e retorna as coordenadas latitudes e longitude devidamente cadastradas para a construção da localização e assim, centralizando e marcando no mapa a posição referente à unidade de coleta.

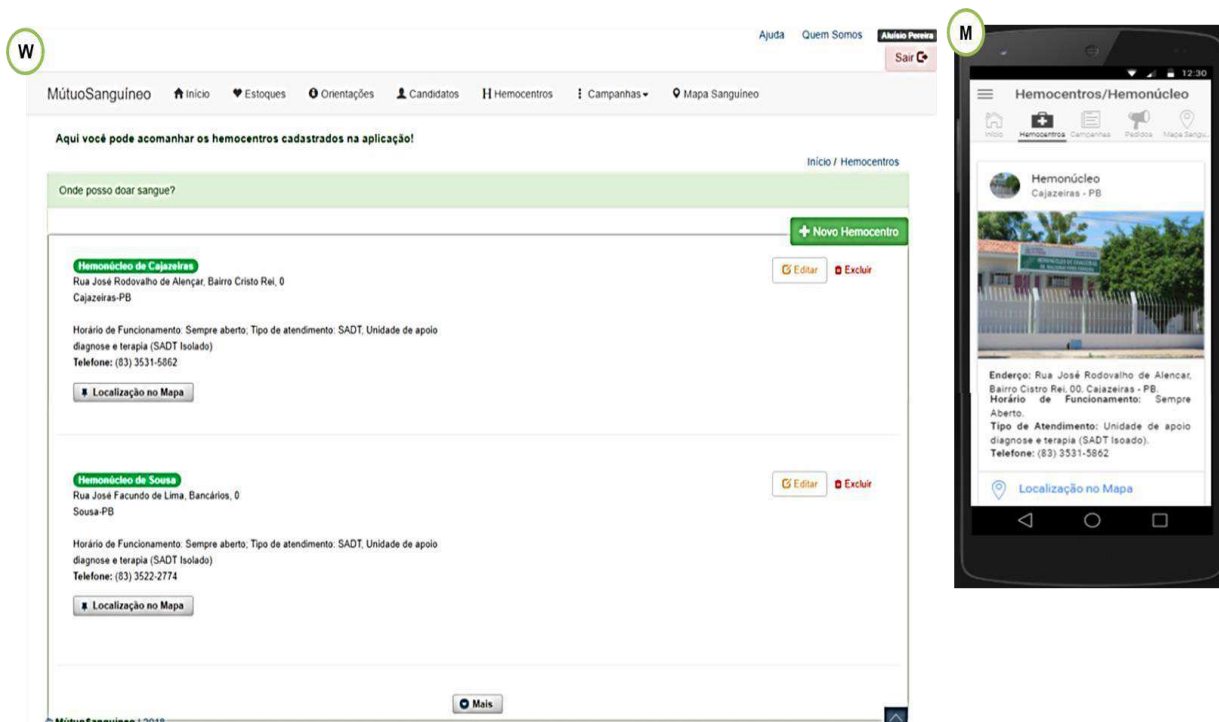


Fig.7– PáginaWeb e Mobile dos hemocentros/hemonúcleos cadastrados (RF5 e RF12)

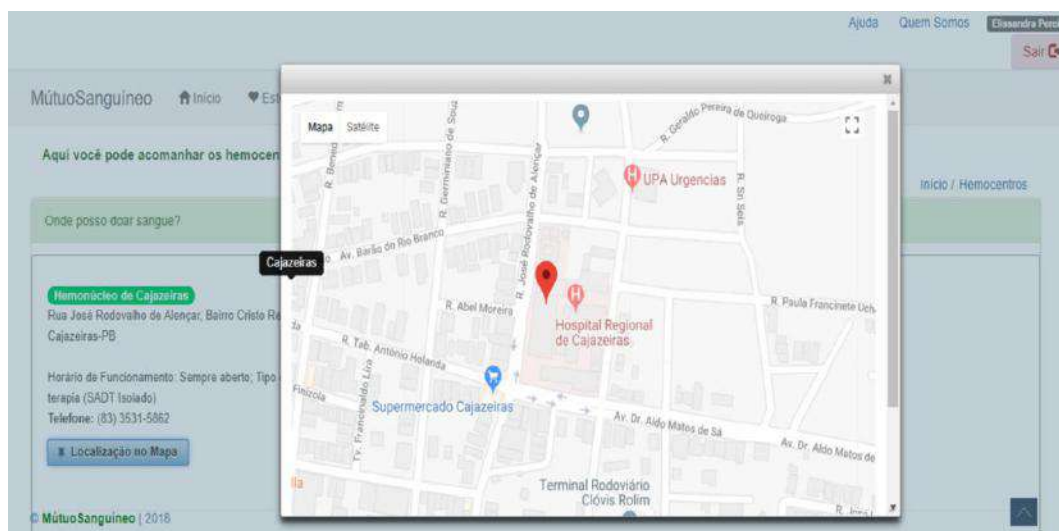


Fig.8 – Página Localização no Mapa do hemocentro/hemonúcleo.

A exibição do mapa de tipo sanguíneo e fator RH (Grupo Sanguíneo), também é uma funcionalidade essencial do sistema, uma vez que a mesma proporcionar ao administrador dos hemocentros/hemonúcleo vislumbraas informações disponibilizadas pelos usuários ao se cadastrarem na aplicação, possibilitando com isso apoiar a tomada de decisões, buscando atrair novos doadores, assim como para fins de manutenção dos níveis de estoques, permitindo por meio das informações desta funcionalidade trabalhar campanhas e ações de coletas ambulatorias voltadas para dadas regiões /bairros de uma cidade, dependendo do quantitativo de candidatos à doação nestas proximidades e as necessidades do hemocentro em questão. Por meio da página de mapa sanguíneo, conforme apresenta a Fig.9, o usuário administrador se depara com um

ambiente para a exibição no mapa, a partir das informações fornecidas (tipos sanguíneos, estado e cidade) para realização da busca, a marcação das coordenadas de candidatos à doação de sangue cadastrado na aplicação que optaram em fornecer as informações de localização, referentes resultados relativos às informações.

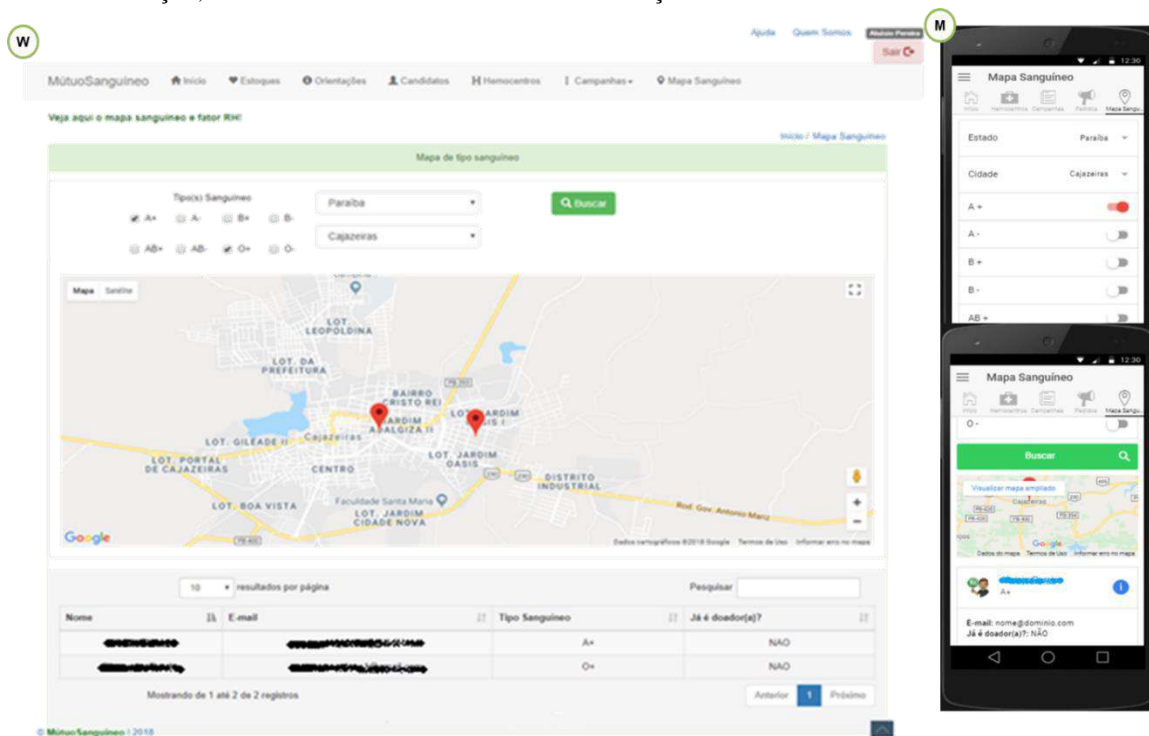


Fig.9– TelaWeb e Mobile visualização do mapa por tipo sanguíneo (RF16)

A Fig.10 apresenta um agrupamento com das demais implementações.

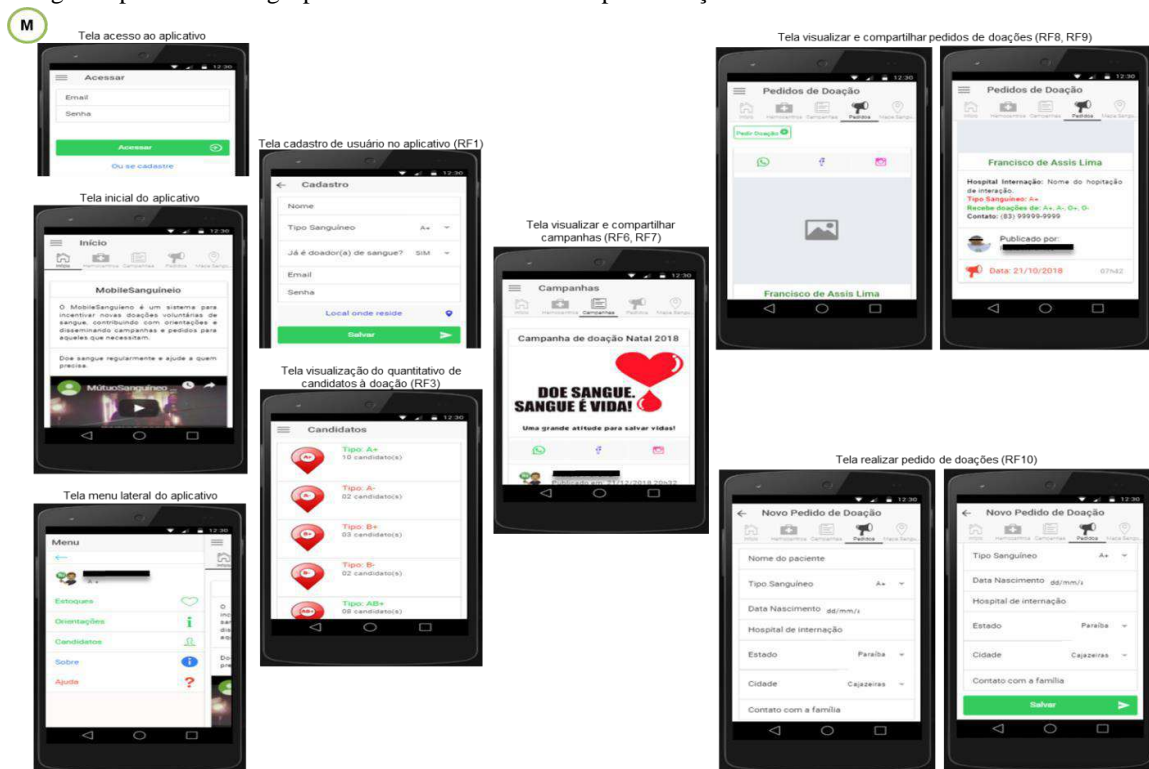


Fig.10 – Agrupamento de figuras das telas do aplicativo Mobile (RF1, RF3, RF6, RF7, RF8, RF9 e RF10)

No decorrer do desenvolvimento do sistema foi realizado o lançamento e validação de oito versões, para análise junto aos interessados no Hemonúcleo de Cajazeiras – PB, o qual obteve a confirmação e o posicionamento do(a) representante institucional em cada caso de “Excelente” para as implementações das funcionalidades conforme exemplifica e apresenta Fig.11. Sendo assim, possível contemplar a Versão 0.8 alcançando os objetivos inicialmente descritos para o desenvolvimento do sistema colaborativo deste estudo.

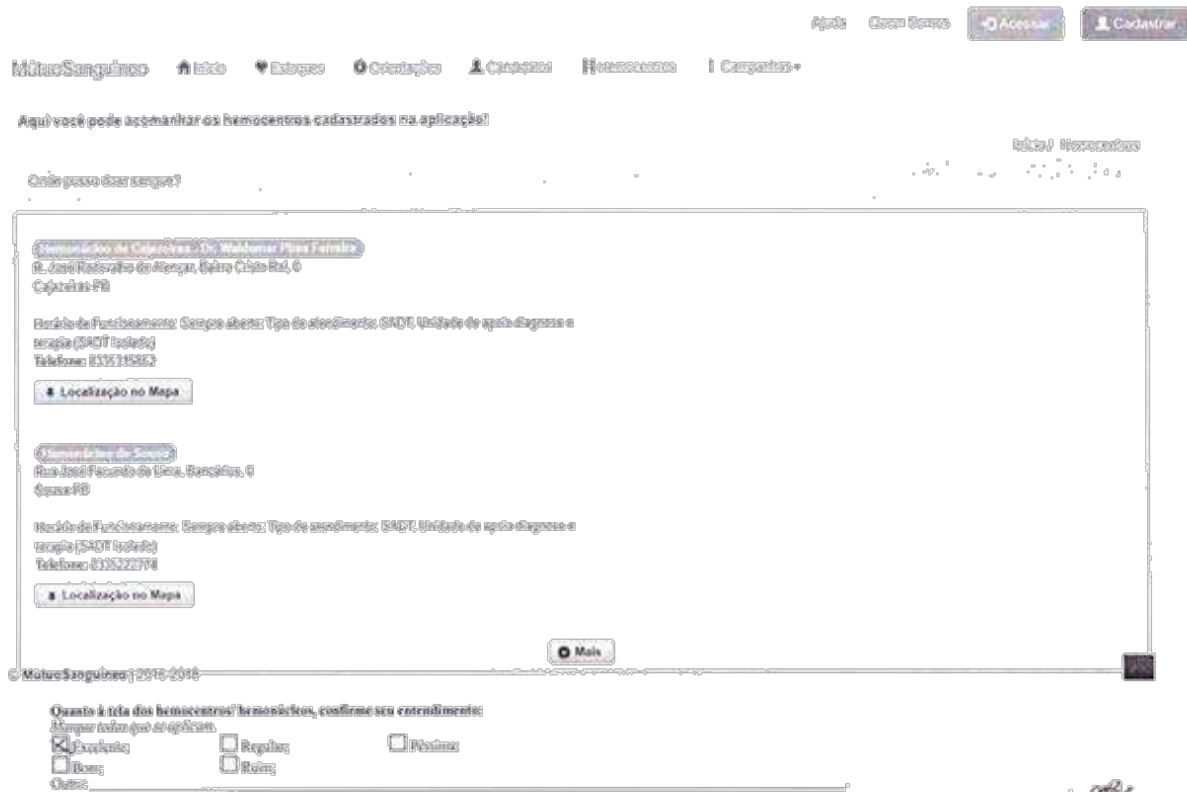


Fig.11 – Questionário de aceitação e posicionamento quanto à implementação para a tela das informações e localização dos hemocentro/hemonúcleo

Através da definição da região de Cajazeiras, Paraíba, Brasil como principal circunscrição para a realização deste estudo, foi possível também levantar ferramentas com propostas parecidas ao MútuoSanguíneo, encontrando os sistemas (S) que mais se assemelham, sendo eles:

- S1 HemoLiga¹²;
- S2 Doe Sangue PB¹³;
- S3 Blog Hemonúcleo Cajazeiras¹⁴.

Adotando uma perspectiva qualitativa, os sistemas S1, S2 e S3 com propostas semelhantes serviram como base para ser realizado um estudo comparativo entre as funcionalidades contempladas por tais sistemas e destacar as peculiares ao sistema colaborativo desenvolvido neste trabalho conforme apresenta a Tabela 2.

Tabela 2– Comparação entre sistemas relacionados e o sistema deste estudo

FUNCIONALIDADES	S1	S2	S3	Mútuo Sanguíneo
Cadastro de candidatos	✓	✗	✗	✓
Cadastro de voluntários para participar de campanhas	✗	✓	✗	✗

¹²<http://hemoliga.com.br>

¹³<http://doesanguepb.com.br>

¹⁴<http://hemonucleocajazeiras.blogspot.com.br>

Exibir requisitos e orientações para doação.	✓	✓	✓	✓
Exibir quantidade de cadastrados por tipo sanguíneo.	✗	✗	✗	✓
Gerar identificação de doador	✓	✗	✗	✗
Exibir informações de estoques do hemocentro.	✓	✗	✗	✓
Exibir informações de estoque por tipo sanguíneo.	✓	✗	✗	✓
Exibir locais de doação.	✓	✓	✓	✓
Exibir localização de hemocentro no mapa	✓	✗	✗	✓
Realizar pedido de doação de sangue.	✗	✓	✗	✓
Compartilhar pedido de doação de sangue.	✗	✗	✗	✓
Divulgação de campanhas de coleta de sangue.	✓	✓	✓	✓
Compartilhar campanhas de coleta de sangue.	✗	✗	✗	✓
Permitir gerar dúvidas, sugestões, reclamações.	✗	✓	✗	✗
Exibir mapa de tipos sanguíneo por cidade.	✗	✗	✗	✓

Legenda: S1 – HemoLiga; S2 – Doe Sangue PB; S3 – Blog Hemonúcleo Cajazeiras; ✓ – possui a funcionalidade; ✗ – não possui a funcionalidade.

Observando o comparativo da Tabela 2 é possível perceber que o MútuoSanguíneo (sistema *Web* e aplicativo desenvolvidos) proporciona uma compatibilização entre funcionalidades mescladas pelos demais sistemas, assim como, apresenta funcionalidades peculiares como é o caso da exibição do mapa sanguíneo de candidatos a doação de sangue.

IV. CONCLUSÃO

O MútuoSanguíneo desenvolvido é uma iniciativa que visa facilitar a interação entre instituições coletoras de sangue, doadores e pacientes. Por meio das funcionalidades existentes tanto no sistema *Web* e no aplicativo, os envolvidos contribuem espontaneamente para disseminar as ações de apoio e incentivo à prática da doação de sangue.

Com a realização deste trabalho foi possível entender que as práticas da Política Nacional de Promoção da Doação Voluntária de Sangue no Brasil podem ser apoiadas por abordagem como a resultante do presente estudo. Foi possível também adquirir, conhecer e entender que um processo de desenvolvimento de sistemas *Web* e *Mobile* possibilita uma interação constante com os interessados na abordagem proposta produziu como resultado uma melhor produtividade e aceitação, permitindo uma boa experiência na aplicação de metodologias ágeis para melhor organizar etapa do trabalho.

Na versão atual do sistema desenvolvido neste estudo, o mesmo já proporciona um ambiente que possibilita aos usuários realizar pedidos de doações de sangue para paciente específico, divulgar campanhas de abrangência geral, consultar informações dos locais para doação, se manter atualizado sobre os níveis de estoque de sangue dos hemocentros e orientar-se sobre os procedimentos necessários para se tornar doador de sangue.

REFERÊNCIAS

- [1] BRASIL. Ministério da Saúde. **Apenas 1,8% dos brasileiros são doadores de sangue**. Governo do Brasil. 2017. Disponível em: <<http://www.brasil.gov.br/saude/2017/06/apenas-1-8-dos-brasileiros-sao-doadores-de-sangue>>. Acesso em: 18 fev. 2018.
- [2] BRASIL. Ministério da Saúde. **Manual de orientações para promoção da doação voluntária de sangue**. Secretaria de Atenção à Saúde. Departamento de Atenção Especializada e Temática. – 1. ed., 1. Reimpr. Brasília, 2015.
- [3] GUIMARÃES, J. **Ministério da Saúde gastou R\$ 532 milhões em publicidade nos últimos três anos**. Portal R7. 2016. Disponível em: <<https://noticias.r7.com/saude/ministerio-da-saude-gastou-r-532-milhoes-em-publicidade-nos-ultimos-tres-anos-19052016>>. Acesso em: 22 jan. 2018.
- [4] CAVALCANTI, L. **Ministério da Saúde lança campanha para incentivar doação de sangue**. Correio Brasiliense 2017. Disponível em: <http://www.correiobraziliense.com.br/app/noticia/brasil/2017/06/14/internas_polbraeco,602576/ministerio-da-saude-lanca-campanha-para-incentivar-doacao-de-sangue.shtml>. Acesso em: 21 fev. 2018.
- [5] MASSUCHETTO, Vinícius André. **Sistemas colaborativos de apoio à decisão: uma proposta de combinação de metodologias para a geração de alternativas estratégicas**. São Paulo: IPEN, 2015. Dissertação (Mestrado) – Instituto de Pesquisas Energéticas e Nucleares, Autarquia associada à Universidade de São Paulo, 2015.
- [6] BORGES, Marcos Roberto da Silva. **Uma análise do desenvolvimento de Sistemas Colaborativos apoiado em Práticas Ágeis**. Rio de Janeiro: UFRJ, 2015. UFRJ - Universidade Federal do Rio de Janeiro, 2015.

- [7] RIOS, J. A; REIS, L. R. dos; SOUZA, C. R. B de. **Comunidades de práticas baseadas na web**: um estudo de caso no programa profuncionário. Louro Feitas: IFBA, 2017. OBRA DIGITAL, Núm. 14, Febrero - agosto 2018, pp. 102-123, e-ISSN 2014-5039.
- [8] PRESSMAN, R. S; MAXIM, B. R. **Engenharia de software**: uma abordagem profissional. 8. ed. Porto Alegre: AMGH, 2016.
- [9] SCHWABER, K; SUTHERLAND, J. **Um guia definitivo para o Scrum**: As regras do jogo. Processo de Desenvolvimento de Software, 2013.
- [10] GUEDES, G. T. A. UML 2: uma abordagem prática. 2. ed. São Paulo: Novatec Editora, 2011.
- [11] BAPTISTELLA, A. J. **Abordando a arquitetura MVC e Design Patterns**: Observer, Composite, Strategy. 2015. Disponível em: <<http://www.linhadecodigo.com.br/artigo/2367/abordando-a-arquitetura-mvc-e-design-patterns-observer-composite-strategy.aspx>>. Acesso em: 16 jan. 2018.
- [12] ORACLE. Java Platform, Enterprise Edition. **Release 7**. September 2014. Disponível em: <<https://docs.oracle.com/javaee/7/tutorial/title.htm>> Acesso em: 17 fev. 2018.

Oxidation time of Ascorbic Acid in two different types of Solutions

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Abstract— The article evaluated the survival function and time of failure (ascorbic acid oxidation) in natural fruit juices, comparing to oxidation of this vitamin in simple aqueous medium. The analysis showed that the oxidation in natural fruit juices (orange, barbados cherry and cashews) have failed quickly compared to simple aqueous medium.

Keywords— Survival Function. Risk ratio. Vitamin C.

I. INTRODUCTION

Antioxidants are chemical compounds that can prevent or reduce the oxidative damage of lipids, proteins and nucleic acids caused by reactive oxygen species, which include free radicals, that is, antioxidants have the ability to react with free radicals and thus restrict the harmful effects on the body. Antioxidant supplementation can be used in situations where normal body defense mechanisms are not sufficient to attenuate the harmful action of free radicals from metabolic activities (Picchio et al., 2013).

Natural substances exhibit antioxidant activities that help decrease the incidence of cardiovascular disease, inflammation, brain dysfunction, and delay early aging (ROCHA et al., 2013).

Fruits and vegetables contain many compounds with potential antioxidant activity, such as phytochemical antioxidants, including simple phenolic compounds, glycosides and flavonoids such as vitamins C and E. Vitamin C also helps the body maintain levels of vitamin E, liposoluble antioxidant, and also acts as an anti-stress agent, favoring the reduction of glucocorticoid rates (FERNANDES et al., 2013).

Most of the antioxidants present in citrus are vitamin C and polyphenols, especially flavonoids. Vitamin C provides protection against uncontrolled oxidation in the aqueous medium of the cell, due to its high reducing power. Polyphenols are substances with great power to neutralize the molecules of free radicals (KLIMCKAC; PATIL, 2007).

Vitamin C is the common name given to 2,3-enediol-L-gulonic acid which is a powerful antioxidant because it prevents oxidation, that is, the loss of electrons. The body has different antioxidant defense systems, however, when imbalance occurs in the antioxidant defense, there is an increase in the number of free radicals, a process known as oxidative stress. Ascorbic acid (vitamin C) molecules undergo oxidation before other molecules oxidize, preventing and protecting these other oxidation molecules (BIANCHI; ANTUNES, 1999).

It is known that during food storage and processing, most vitamins can be spoiled due to chemical reactions, especially by oxidation. This is a serious problem, especially in relation to the conditioning of natural foods, since the simple contact with the oxygen of the air during the storage time favors the oxidation reactions of the vitamins inherent in the composition of these foods (BRITO et al.) Foods like cashew, acerola and orange have high amounts of ascorbic acid, and are generally ingested by man in the form of juices. As soon as the juice of these fruits is extracted, the process of oxidation of vitamin C by the oxygen of the air begins, which means that in the course of time the amount of ascorbic acid present in the juice decreases. Oxidation may be represented by the conversion of ascorbic acid to dehydroascorbic acid as shown in

Figure 1.

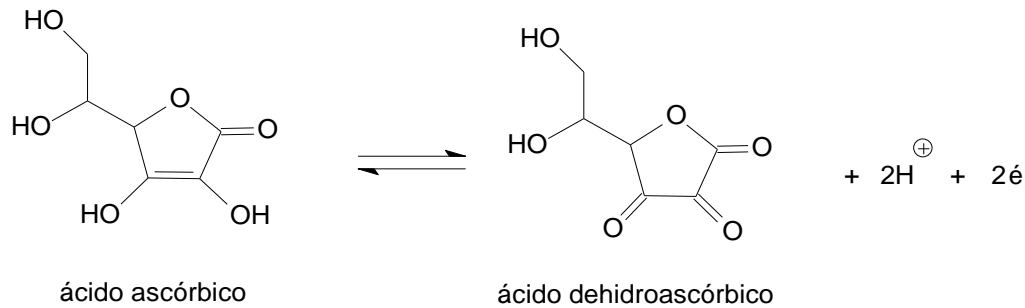


Fig.1: Oxidation of ascorbic acid to dehydroascorbic acid.

Source: Organized by the authors.

In this sense, the study of the failure time, or the occurrence of the oxidative process of ascorbic acid, in different solutions and in ambient conditions, allows to evaluate packaging and preparation techniques, in order to optimize its use and consumption. Therefore, the present study aims to evaluate the failure time and risk function of ascorbic acid oxidation in natural fruit juices, comparing to the oxidation of this vitamin in a simple aqueous medium

II. MATERIALS AND METHODS

2.1. Sample Preparation Planning and Procedures

To carry out the analyzes, oxidation titrations were made using iodine solution (I₂) 0.01 molL⁻¹ as titrant and starch (1%) as indicator of the turning point. The iodine (I₂) acts as an oxidizing agent, causing oxidation of the ascorbic acid contained in the solution to dehydroascorbic acid. Initially the solution is colorless, but when there is excess iodine, ie all ascorbic acid has been oxidized, this solution turns blue, indicating the end of the titration.

For determination of the ascorbic acid content in orange juice, 25.0 ml of orange juice was pipetted and transferred to a 100.0 ml volumetric flask and the volume was quenched with distilled water. Then 25.0 mL of this solution was pipetted into a 125.0 mL Erlenmeyer flask and 5.0 mL of 1% starch indicator solution (m / m) was added. The solution was titrated with 0.01 molL⁻¹ iodine until a permanent blue color appeared. The concentration of ascorbic acid present in the juice over 2.5 h was calculated and then compared with the other results obtained.

Regarding the determination of the oxidation rate of ascorbic acid present in aqueous medium, the same initial amount of ascorbic acid PA present in orange juice solubilized in distilled water was weighed and transferred to a volumetric flask of 1000.0 ml and the volume completed with distilled and deionized water. 25.0 mL of

this solution was then pipetted to a 125.0 mL Erlenmeyer flask, thereby initiating the titration. The concentrations of ascorbic acid present in the aqueous medium over 2.5 h were determined at each 30 minute interval and under magnetic stirring at 7,000 rpm. Then, they were compared with the results obtained in the oxidation of ascorbic acid present in natural fruit juice.

In the analysis of ascorbic acid present in acerola juice, 252.0 g of fruit were used, which produced 125.0 mL of juice after extraction. The juice diluted with 200.0 mL of water, raising to a total volume of 325.0 mL of solution. From this solution were pipetted 25.0 mL and transferred to a volumetric flask of 100.0 mL, completing with distilled water. Then 25.0 mL were pipetted from the volumetric flask to a 125.0 mL Erlenmeyer flask and titrated.

Regarding the determination of the oxidation rate of ascorbic acid present in aqueous medium, the same initial amount of ascorbic acid present in acerola juice was weighed, dissolved in water and transferred to a 1000.0 mL volumetric flask and filled with deionized water. Then 25.0 mL was pipetted into a 125.0 mL Erlenmeyer flask and titrated with 0.01 mol L⁻¹. The concentrations of ascorbic acid present in the aqueous medium in the course of 2.5 h were determined by the same procedure, and then compared with the results obtained in the oxidation of the natural juice.

For the analysis of cashew juice, 440.0 g of the fruit were used, which provided a volume of pure juice, after filtration maceration, of 437.6 mL. To this juice was added 150.0 mL of water, thus raising to a final volume of 587.6 mL of solution. From this solution were pipetted 25.0 mL and transferred to a volumetric flask of 100.0 mL, completing with distilled water. Then 25.0 mL were pipetted from the volumetric flask to a 125.0 mL Erlenmeyer flask and titrated.

Ascorbic acid content of the cashew juice and in aqueous medium were weighed, the same initial amount of ascorbic acid present in the cashew juice was weighed,

dissolved in deionized water and transferred to a 1000.0 mL volumetric flask and volume with distilled water. Subsequently, 25.0 mL were pipetted and transferred to a 125.0 mL Erlenmeyer flask and titrated with 0.01 mol L⁻¹ I₂ solution. The concentrations of ascorbic acid present in aqueous medium in the course of 2.5 h were determined and calculated by the same procedure, and then compared with the results obtained in the natural juice analysis.

The determination of ascorbic acid concentration as a function of the time of exposure to air was carried out at intervals of 30 minutes in triplicates for a period of 2.5 hours, that is, 150 minutes exposed to oxygen from the

air, under agitation at 7,000 rpm. To calculate the mass of ascorbic acid present in each solution, the following procedure was used:

$$\text{Mass of Vitamin C} = M * V * MM, \text{Equation 1}$$

where, M is the molarity of iodine (0.01 molL⁻¹); V is the volume spent in liters of iodine in titration and MM is the molar mass of ascorbic acid (176 mols / g).

In Table 1 the spent volumes of iodine in each titration are described. It should be noted that the volumes of 0.01 molL⁻¹ spent I₂ solution are obtained by the average of three titrations (triplicate) performed.

Table 1: Volumes used of I₂ (0,01 molL⁻¹) in the titrations of preparation of the samples with ascorbic acid, in simple aqueous solutions (SAS) and in natural fruit juices (SNF).

Time (min)	Volume spent (in ml) on the titrations of the simple aqueous solutions			Volume spent (in mL) spent on titrations of natural fruit juices		
	Orange	Acerola	Cashew	Orange	Acerola	Cashew
0	2,65	39,50	7,25	2,65	39,50	7,25
30	2,38	34,80	5,60	2,50	35,55	6,50
60	1,98	31,08	5,24	2,20	31,70	5,85
90	1,78	26,80	4,50	2,00	28,50	5,30
120	1,56	24,38	3,91	1,80	27,00	4,90
150	1,45	23,21	3,26	1,65	26,50	4,35

Source: Prepared by the authors.

2.2. Statistical treatment of collected data

After the data collection, a statistical study was performed with the measurements of ascorbic acid concentration (g / L) in each of the experimental samples. The aim is to demonstrate the failure performance (decrease of the ascorbic acid concentration function) over the time measured in minutes. The log-normal distribution of sample reliability was obtained from the probability density function (pdf), given by:

$$F(t) = \frac{1}{\sigma \sqrt{2\pi}} \exp\left(-\frac{(\ln(x)-\mu)^2}{2\sigma^2}\right), \text{Equation 2}$$

where, μ are the parameters obtained in each sample and, σ is the scale of the parameters evaluated. The estimates of the likelihood function of the parameters are estimated by the maximum likelihood procedure (GIESBRECHT; KEMPTHORNE, 1966).

As for the survival function S (t), which represents in the experiment the probability of an "ascorbic acid" unit of concentration "surviving", above the time interval in t (minutes), is obtained naturally by:

$$S(t) = 1 - F(t), \text{Equation 3}$$

and the confidence limits for a given estimate of the function S (t), is obtained by:

$$S_L(\hat{Z}) = S(\hat{Z}_2), \text{to the lower limits; Equation 4}$$

$$S_U(\hat{Z}) = S(\hat{Z}_1), \text{to the upper limits Equation 5}$$

Where,,

$$Z_1 = \hat{z} - z_\alpha \sqrt{\text{Var}(\hat{z})}; \text{Equation 6}$$

$$Z_2 = \hat{z} + z_\alpha \sqrt{\text{Var}(\hat{z})}, \text{Equation 7}$$

in which, $z_\alpha = (1 + \alpha) / 2$ for the critical value of confidence, given in a standardized normal distribution (RIGDON; BASU, 2000).

Regarding the variance of the survival probabilities (survival probabilities) of the samples, it is given by:

$$\hat{z} = \frac{x - \hat{\mu}}{\hat{\sigma}}, \text{Equation 8}$$

or yet,

$$\hat{z} = \frac{\ln x - \hat{\mu}}{\hat{\sigma}}, \text{Equation 9}$$

And, therefore, for the log-normal distribution, one has:

$$\text{Var}(\hat{z}) = \frac{\text{Var}(\hat{\mu}) + \hat{z}^2 \text{Var}(\hat{\sigma}) + 2\hat{z} \text{Cov}(\hat{\mu}, \hat{\sigma})}{\hat{\sigma}^2} \text{Equation 10}$$

In sequence, the instantaneous failure rate (or hazard rate) was obtained for each time t (in minutes), as shown in the hazard function. It is possible to consider in this specific study, in which phase of experimental life, the probability of occurrence of failure is greater or lesser for each sample group, and also the expectation of its duration (or instantaneous failure rate at a given moment, t)

The risk function is given by:

$$h(t) = \frac{f(t)}{1-F(t)}, \quad \text{Equation 11}$$

where f (t) and F (T) are cdf (cumulative distribution function) and pdf (probability density function), respectively, of the chosen distribution (MEEKER and ESCOBAR, 1998). The Reliability / Survival Analysis package and the Parametric Distribution Analysis-Right

Censoring function of the MINITAB software (version 17) were used for the statistical study.

III. RESULTS AND DISCUSSION

After the determination of the ascorbic acid content in fruit juices, a comparison was made of the oxidation rate of ascorbic acid by air oxygen in fruit juices and also simultaneously a simple aqueous solution containing initially at the initial time, the same amount of ascorbic acid in fruit juices.

From the data presented in Table 2, it can be seen that the oxidation rate of ascorbic acid was higher when compared to the same concentration of ascorbic acid in fruit juice. It is noted that, for example, for orange juice, a concentration of 0.746 g / L of ascorbic acid was exposed prior to oxidation

Tabela 2: Concentrations of ascorbic acid present in simple aqueous solutions (SAS) and natural fruit juices (SNF), at different times evaluated in the study.

Time (min)	Concentration of ascorbic acid (g / L) in single aqueous solution			Concentration of ascorbic acid (g / L) in natural fruit juices		
	Orange	Acerola	Cashew	Orange	Acerola	Cashew
0	0,746	28,920	2,739	0,746	28,920	2,739
30	0,670	25,479	2,117	0,704	26,028	2,458
60	0,557	22,756	1,981	0,619	23,209	2,212
90	0,501	19,622	1,702	0,563	20,866	2,004
120	0,439	17,850	1,478	0,506	19,768	1,853
150	0,408	16,994	1,233	0,465	19,402	1,645

Source: Prepared by the authors.

When subjected to oxidation, the concentration of ascorbic acid found after 30 minutes of stirring was 0.704 g / L, whereas in the simple aqueous solution of ascorbic acid, from the initial concentration of the same 0.746 g / L, a decrease was observed to 0.670 g / L after 30 minutes. This higher oxidation in the simple aqueous solution of ascorbic acid, compared to the oxidation of the ascorbic acid present in the fruit, was observed at all determined times, according to Table 2.

As for the statistical study of the failure time, for samples of Orange in simple aqueous solution (SAS) and in natural fruit juices (SNF), it was noticed that those in aqueous solution failed before and unlike the samples in natural fruit juices (Figure 1). The hazard function indicates that the probability of occurrence of failure (oxidation of ascorbic acid) in the samples in natural juices occurs late, already in the final phase of experimental evaluation.

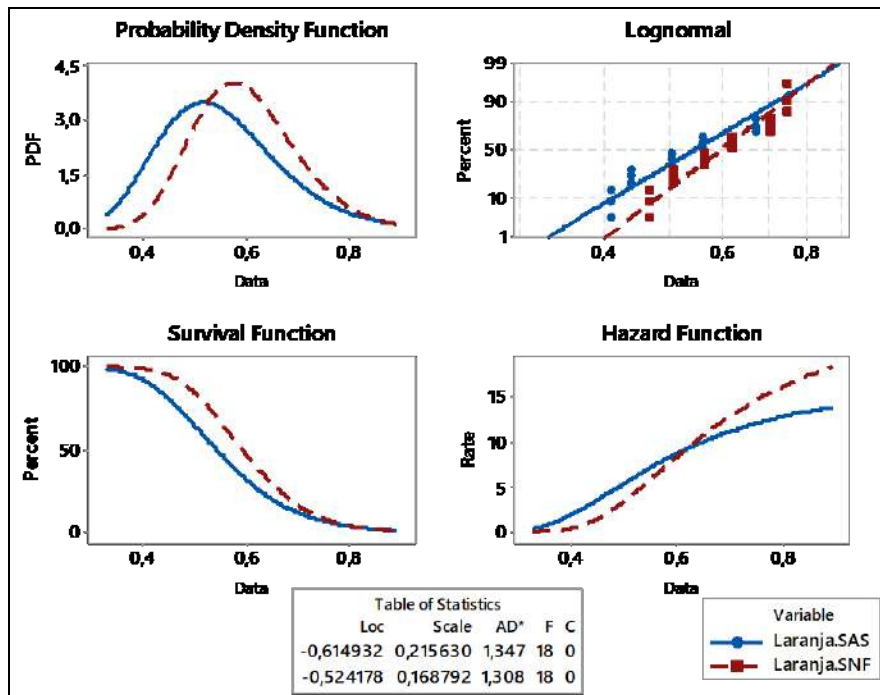


Fig.1: Distribution of the estimates by the maximum likelihood criterion of the complete ascorbic acid (g / L) oxidation data for triplicate samples of orange in single aqueous solution (SAS) and in natural fruit juices (SNF).

Source: Prepared by the authors.

The same considerations can be attributed to the other experimental samples, containing acerola and cashew in simple aqueous solution and in natural fruit juices. In the acerola samples, the survival distribution and the risk rate function are quite similar with the samples containing orange (Figure 2).

In general, the characteristic of the solution is determinant for the distribution of the ascorbic acid concentrations, throughout the time of evaluation of the experiment. The probability of oxidation of ascorbic acid, which is already close to the final phase of the experiment, is more easily perceived from the risk ratio function for the two samples (orange and acerola).

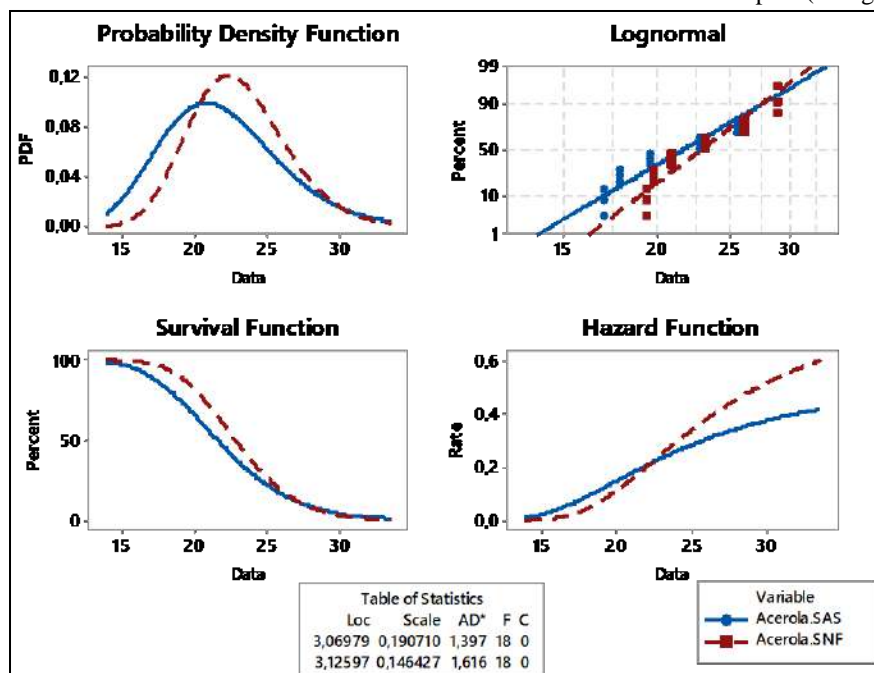


Fig.2: Distribution of the estimates by the maximum likelihood criterion of the complete ascorbic acid (g / L) oxidation data for the triplicate samples of acerola in single aqueous solution (SAS) and in natural fruit juices (SNF).

Source: Prepared by the authors.

Likewise, for Cashew samples in simple aqueous solution and in natural fruit juices, it was observed that those in aqueous solution failed before and unlike samples in natural fruit juices (Figure 3). The hazard function (Hazard Function) has demonstrated that the probability of occurrence of failure in the samples in natural juices is also later in the final phase of experimental evaluation, contrary to what happens in the initial phase of the experiment.

It should be noted that the greatest difference between the distribution of data evaluated in the samples, considering the probability of survival, more extensive in

the treatments with natural fruit juices in relation to the aqueous medium, and in relation to the risk rate function.

For this set of samples (using cashew), the probability of occurrence of failure (oxidation of ascorbic acid) in simple aqueous solution is much less pronounced and, at least visually, a more discrete distribution. Compared to the other samples (orange and acerola), the distance between the hazard rate function in the final phase of the experiment is much wider for the two solution models (aqueous solution versus solution with fruit juice).

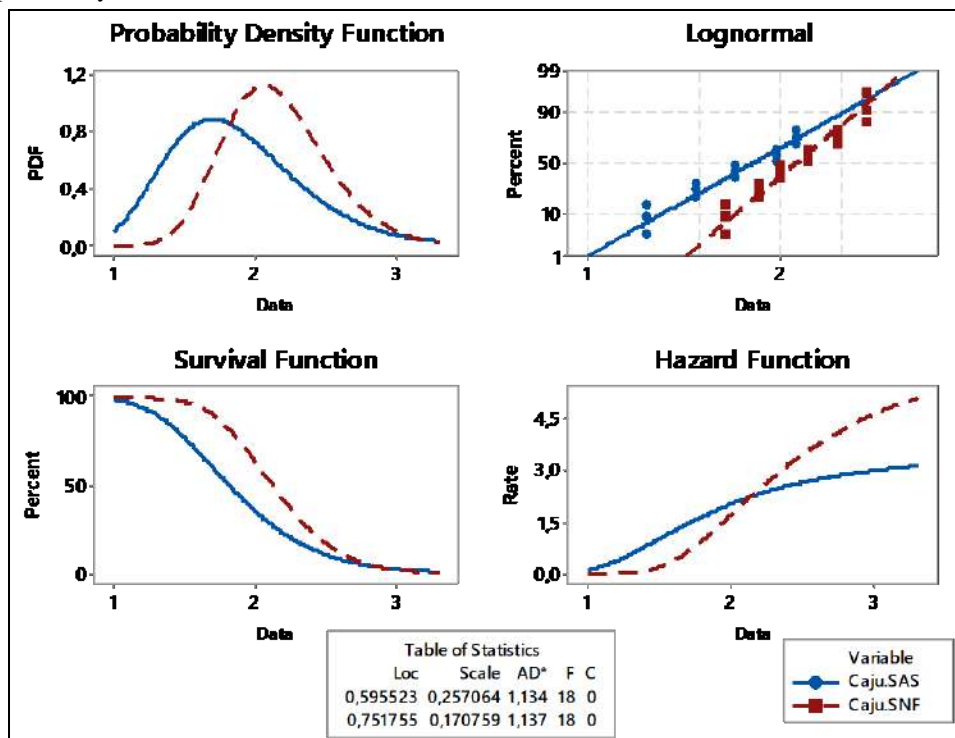


Fig.3: Distribution of the estimates by the maximum likelihood criterion of the complete ascorbic acid (g/L) oxidation data for triplicate samples of cashew nuts (SAS) and natural fruit juices (SNF).

Source: Prepared by the authors.

Therefore, the simple aqueous solution allows for greater oxidation of ascorbic acid in the different types of fruits used in the experiment compared to the solution containing natural fruit juice. The oxidation rate, however, is more accentuated at the end of the experiment, using orange and acerola, compared to cashew nuts.

IV. CONCLUSIONS

The present study allowed to conclude that:

- all the juices used in the experiment (orange, acerola and cashew), in simple aqueous solutions, failed very quickly when compared to samples in solution of natural fruit juices.

- There is a presence of natural antioxidants in fruits that prevent the oxidation of ascorbic acid in dehydroascorbic acid as fast as its oxidation in its pure form, ie without the action of these natural antioxidants.
- acerola juice had a higher ascorbic acid content, and demonstrated a higher failure rate (ascorbic acid oxidation) during the 150 minutes of the experiment, indicating that there is a greater antioxidant "protection" of vitamin C in orange and cashew juice in relation to acerola juice.
- the characterization of these natural antioxidants in orange, cashew and acerola is proposed in future studies, considering the ability to retard the rate of

oxidation of ascorbic acid in order to attenuate the harmful effects of oxidative stress intrinsic to our body's metabolic activities.

REFERENCES

- [1] BIANCHI, M. L. P.; ANTUNES, L. M. G. Radicais Livres e os Principais Antioxidantes da Dieta. **Revista de Nutrição**. v.12, n.2, p.123-130, 1999.
- [2] BRITTO, D.; MOURA, M. R.; AOUADA, F. A.; MATOSSO, L. H. C.; ASSIS, O. B. G. N,N,N-Trimethylchitoson nananoparticles as a vitamin carrier system. **Food Hydrocolloids**. v.27, n.4, p. 487-493, 2012.
- [3] FERNANDES, J. I. M.; SAKAMOTO, M. I.; PEITER, D. C.; GOTTARDO, E. T.; TELLINI, C. Relação vitamina E: vitamina C sobre a qualidade da carne de frangos submetidos ao estresse pré-abate. **Arq. Bras. Med. Vet. Zootec**. v.65, n.1, p. 294-300, 2013.
- [4] GIESBRECHT, F.; KEMPTHORNE, A. H. Maximum Likelihood Estimation in the Three-parameter Lognormal Distribution. **Journal of the Royal Statistical Society B** 38, p. 257-264. 1966.
- [5] KLIMCKAC, J. G. K.; PATIL, B. S. In vitro evaluation of the antioxidant activities in fruit extracts from citron and blood orange. **Food Chemistry**. v. 101, n. 1, p. 410-418, 2007.
- [6] MEEKER, W. Q.; ESCOBAR, L. A. **Statistical Methods for Reliability Data**. John Wiley & Sons, Inc. 1998. 712p.
- [7] PICHHI, M. G.; DEMINICE, R.; OVÍDIO, P. P.; JORDÃO, A.A. Efeitos do ácido ascórbico nos biomarcadores de estresse oxidativo em nadadores de elite. **Rev. Bras. Med. Esporte**. v.19, n.6, p. 394-398, 2013.
- [8] RIGDON, S. E.; BASU, A. P. **Statistical Methods for the Reliability of Repairable Systems**. John Wiley & Sons. 2000. 290p.
- [9] ROCHA, M. S.; FIGUEIREDO, R. W.; ARAÚJO, M. A. M.; MOREIRA-ARAÚJO, R. S. R. Caracterização físico-química e atividade antioxidante (in vitro) de frutos do cerrado piauiense. **Rev. Bras. Frutic**. v. 35, n. 4, p. 933-941, 2013.

Leguminosae: Biodiversity and Taxonomy for the Northeast Region of Brazil

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Abstract— *The research aimed to know the diversity of Leguminosae in vegetational fragments of Cerrado in the state of Maranhão. Monthly expeditions were carried out in the period between September from 2016 and June 2017 for observation, collection, and identification of botanical material. A total of 68 specimens, 31 genera, and 45 species were cataloged. Of all the specimens collected, the subfamilies Papilionoideae and Caesalpinoideae were the most representative of 21 species each. As for the Life form, was observed that the prevailing growth habit was the bush type (20). Concerning to the physiognomies of the Cerrado, was observed the predominance of the species in the gallery forest environment (28). Taxonomic keys, descriptions and photo plates were elaborated with all the studied species, composing a taxonomic treatment. In this way, it can be established that the Cerrado of Maranhão possesses a diversity of species for the Leguminosae family and that the research carried out has provided a basis for later studies, since these are few for Maranhão.*

Keywords— *Shrubs, Cerrado, Floristic, Papilionoideae, Vigna lasiocarpa.*

I. INTRODUCTION

Within the large diversity of angiosperms, Leguminosae is one of the largest botanical families, with 770 genera and 19.500 species (LEWIS et al., 2005, 2013, LPWG, 2017) and divided into six subfamilies (Caesalpinoideae, Cercidoideae, Detarioideae, Dialioideae, Duparquetioideae, and Papilionoideae) (LPWG, 2017). In Brazil, there are 2.837 species (1.535 endemics) grouped in 222 genera (FLORA DO BRASIL 2020. 2019).

Leguminosae is a family of great economic importance being nourishing cultures important which provides high nourish sources of proteins and micronutrients that can profit the health and the ways of subsistence, especially the developing countries. (GRAHAM & VANCE 2003; YAHARA et al., 2013). Taking up the importance of ecological, are organism good adapted to first colonization an exploration of the several environments, changeovers incurred by the

association of fixative bacteria of nitrogen or with ectomycorrhiza.

The Cerrado has more than 4.800 species of endemic plants and vertebrates, being considered as a global biodiversity *hotspot*. This phytogeographical domain covers three of the largest hydrographic basins in South America, accounting for 43% of Brazil's surface waters outside the Amazon Rainforest (STRASSBURG et al., 2017). Due to its considerable biodiversity, this phytogeographical domain has been the focus of several botanical studies, and therefore, work on the Leguminosae family in the Cerrado is necessary due to its floristic richness (BATALHA, 2011), in addition to the fact that this Phytogeographical Domain is endangered of extinction (STRASSBURG et al., 2017). In the state of Maranhão, there is an ecotone with the Amazon Rainforest and Caatinga (MARANHÃO, 2011). In Maranhão, the São João do Soter City, it is on this

phytogeographic domain, possessing fragments not touched by man, conserving its biodiversity.

The state of Maranhão has large extensions of the Cerrado, with forest formations of significant extensions (standing out deciduous rainforests and, to a lesser extent, dense ombrophilous forests), as well as a large area of ecological tension with the Amazon Rainforest Phytogeographical Domain (MARANHÃO, 2011).

Thus, the research had as objective to know the diversity of Leguminosae in vegetative fragments of Cerrado in the state of Maranhão, specifying: to demonstrate the morphological aspects of the family Leguminosae; to elaborate taxonomic keys for the species studied; to determine the types of growth habits,

phytogeographic domains and environments of occurrence of the species and contribute to the knowledge of the flora Cerrado from Maranhão.

II. MATERIAL AND METHODS

Location and Characterization of the Study Area

The municipality of São João do Sóter ($5^{\circ} 6' 28''$ 'S. and $43^{\circ} 48' 34''$ "W), located in Maranhão, carry over 1.438.1 km² and has 17,238 inhabitants in the last census. The population density is 11.9 inhabitants per km² in the municipality territory Located at 108 meters altitude. In the Municipality, three cerrado areas were sampled: Pedras Village, Redondo Village, and Serra do Cajú Village (IBGE, 2010).

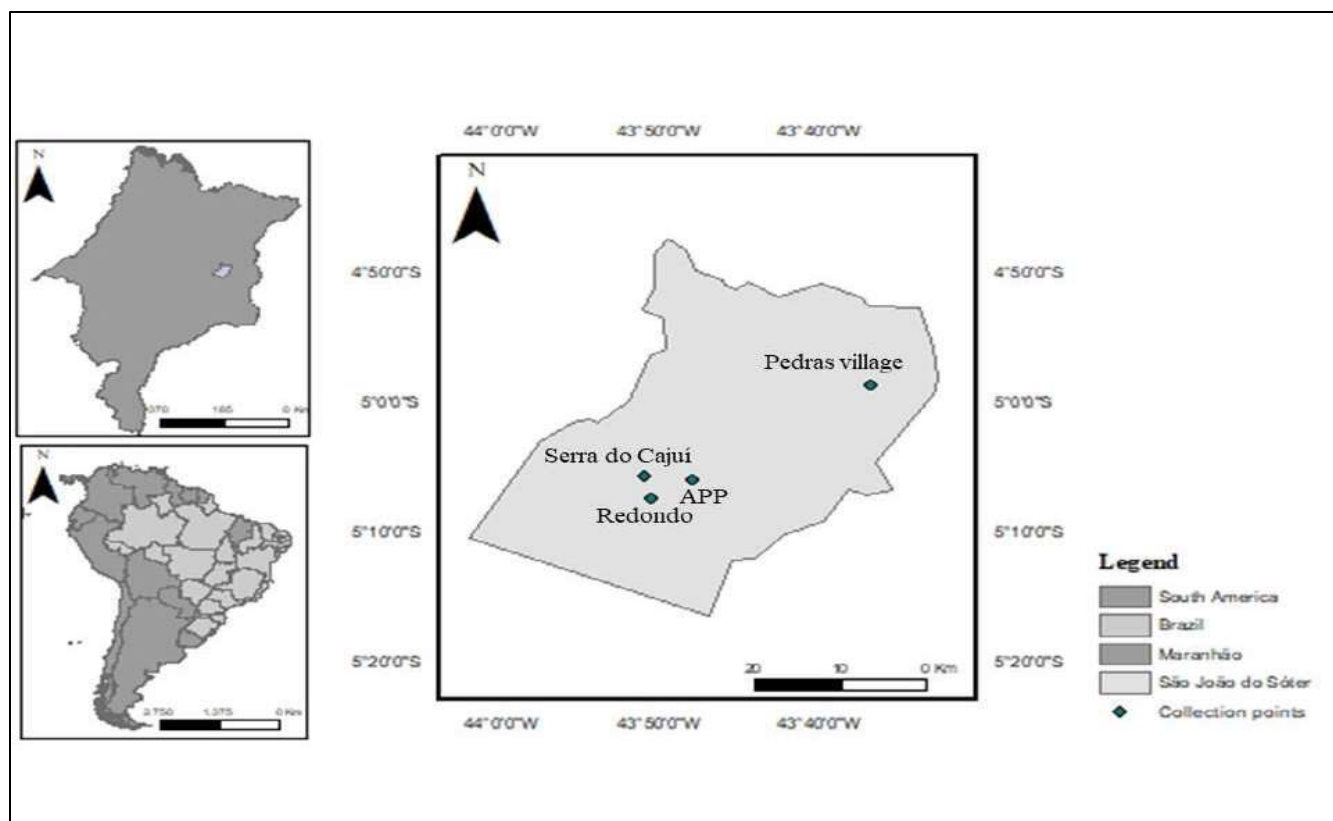


Fig.1: Map of the Municipality of São João do Sóter, Maranhão/Brazil, Collection area of the species of Leguminosae.
Source: IBGE; 2006, Google Earth 2014.

The vegetational fragments sampled are composed of physiognomies of galleries forest, coconut forest and dirty cerrado of herbaceous and perennial plants. The floristic survey comprised three stages: fieldwork, preparation and analysis, and identification of collected material. The collection of the botanical material was carried out from September 2016 to June 2017, through the active search method, with a monthly visit in the study area, comprising the dry and rainy months.

In the fieldwork, the specimens were collected in the fertile state, following the protocol Bononi; Fidalgo (1989). In the preparation of the botanical material, it was herborized and processed, being conditioned as exsiccates in Aluzio Bittencourt Herbarium (HABIT), State University of Maranhão/UEMA. In the identification stage, the specimens were recognized at the species level taking into account the comparison with the specialized material, specific bibliographies (LPWG, 2017),

taxonomic keys, and/or determined and confirmed by a family taxonomist. For the taxonomic treatment, all information and morphological characteristics of each species were observed and recorded. These characteristics formed a description of the plant along with the information of the author of the species, main work, geographical distribution and phytogeographical domains where the species occurs in the Brazilian territory. For the data of the author and main work of all species, was used the Tropicos (2019) (<https://www.tropicos.org/>); and SpeciesLink, CRIA (2019) (<http://www.splink.org.br/>). With the botanical description, dichotomous taxonomic keys of the described species were elaborated, using the taxonomic criteria already presented in the botanical description that better identifies the studied species.

III. RESULTS AND DISCUSSION

Taking into account floristic aspects, Leguminosae is one of the families among the angiosperms that have the richest species in the different phytogeographic domains of Brazil according to Queiroz (2009); Flora do Brasil 2020 (2019). From the obtained data were listed 68 specimens, distributed in 31, genera and 45 species. The representation of species of the Leguminosae subfamilies sampled in this research shows that of the 68 specimens studied, 21 species belong to the subfamily Papilionoideae, 21 belong to the subfamily Caesalpinioideae, 2 species belong to the subfamily Cercidoideae and 1 species belongs to the subfamily Detarioideae, as shown in table.

As for species richness, the subfamilies Papilionoideae and Caesalpinioideae were the most representative, sampled 21 and 19 species respectively (table.1). Papilionoideae is a monophyletic subfamily, with high reliability of phylogenetic reconstruction. The subfamily includes many species of economic importance (TOZZI, 2016). Caesalpinioideae in its present circumscription contains 148 genera and 4.400 species. With pantropical distribution, being common in dewy and dry regions, with a handful of species that extend to the temperate zone (LPWG, 2017). In terms of Brazil distribution, is represented by about 52 genera and 810 species (FLORA DO BRASIL 2020. 2019).

In the physiognomy of occurrence, the specimens were collected, mainly in gallery forests, with 28 species,

Clean Field 7 and Open field 6. Among the plant formations of the Cerrado, the gallery forest, also known as riparian forest or riparian forest by some researchers, is characterized by being associated with watercourses, and this formation, although small, possesses richness, genetic diversity, and acts in the protection of water resources (RIBEIRO, 1998). The two most representative genera in the survey were *Aeschynomene* and *Mimosa* with four species each.

The genus *Aeschynomene* L. has a pantropical distribution, with about 180 species (LEWIS et al., 2005). *Mimosa* L. comprises 540 species, being the second largest genus of the mimosoid clade (SIMON et al., 2011). It is distributed mainly in the neotropical region, counting on approximately 496 endemic taxa of the neotropics and 40 native species of the old world (SIMON et al., 2011; BARNEBY, 1991).

Regarding the life-form, was observed that the predominant habit of growth was the Shrub type with 18 species, after Tree 14 and herb 13. The life-form this family is assorted, from trees, shrubs, sub-bushes to upright herbs, creeping or even climbing (JUDD et al., 1999). Shrubs are characterized by woody structures of varying size, but not more than 6 m in height, and stem with branches much close to the ground (ORMOND, 2006). The bushes are outreached of woody plants, in which the support and stem tissues form layers that are added year after year (BONONI; FIDALGO, 1989).

As for the number of specimens of each species, the species *Phanera variegata* (L.) Benth., *Aeschynomene histrix* Poir., *Libidibia ferrea* (Mart. Ex Tul.) L.P. Queiroz and *Chamaecrista flexuosa* (L.) Greene. were the most representative in the survey, being *P. variegata* the most representative with 5 specimens, and the other 3 specimens each. *P. variegata* is planted in the tropics and hot regions of the world (ISELY, 1990). *P. variegata* is distributed in Amazon Rainforest phytogeographical domain, is found in Colombia, French Guiana and Suriname. In Brazil, it is native throughout the North Region, in the State of Maranhão and Atlantic Rainforest, in the São Paulo State (DOMINGOS, CARPELARI JR, 2016).

Table: Representation of Leguminosae species within each subfamily and Phytogeographical Domains sampled.

°	Subfamily	Species	Phytogeographical Domains
1.		<i>Caesalpinia pulcherrima</i> (L.) Sw.	Amazon Rainforest, Cerrado, Atlantic Rainforest
2.		<i>Cenostigma macrophyllum</i> Tul.	Amazon Rainforest, Caatinga, Cerrado

3.		<i>Chamaecrista flexuosa</i> (L.) Greene.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pampa, Pantanal
4.	CAESALPINIOIDEAE	<i>Chamaecrista nictitans</i> (L.) Moench.	Amazônia, Caatinga, Cerrado, Atlantic Rainforest, Pantanal
5.		<i>Chamaecrista rotundifolia</i> (Pers.) Greene.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pampa, Pantanal
6.		<i>Delonix regia</i> (Bojer ex Hook.) Raf.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pantanal
7.		<i>Dimorphandra gardneriana</i> Tul.	Caatinga, Cerrado
8.		<i>Inga edulis</i> Mart.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
9.		<i>Inga thibaudiana</i> DC.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
10.		<i>Mimosa caesalpinifolia</i> Benth.	Amazônia, Caatinga, Cerrado, Atlantic Rainforest
11.		<i>Mimosa pudica</i> L.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
12.		<i>Mimosa sensitiva</i> L.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
13.		<i>Mimosa xanthocentra</i> Mart.	Amazon Rainforest, Cerrado, Atlantic Rainforest
14.		<i>Parkia platycephala</i> Benth.	Amazon Rainforest, Caatinga, Cerrado
15.		<i>Stryphnodendron adstringens</i> (Mart.) Coville.	Caatinga, Cerrado
16.		<i>Libidibia ferrea</i> (Mart. Ex Tul.) L.P Queiroz	Caatinga, Cerrado, Atlantic Rainforest
17.		<i>Plathymenia reticulata</i> Benth.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
18.		<i>Senna multijuga</i> (Rich.) H.S. Irwin & Barneby.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
19.	<i>Senna reticulata</i> (Willd.) H.S. Irwin & Barneby.	Amazon Rainforest, Caatinga, Cerrado	
20.	<i>Bauhinia dubia</i> G. Don.	Amazon Rainforest, Cerrado	
21.	CERCIDOIDEAE	<i>Bauhinia pulchella</i> Benth.	Amazon Rainforest, Caatinga, Cerrado
22.		<i>Phanera variegata</i> (L.) Benth.	Amazon Rainforest, Cerrado
23.	DETARIOIDEAE	<i>Tamarindus indica</i> L.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
24.		<i>Hymenaea stigonocarpa</i> Mart. ex Hayne.	Amazon Rainforest, Caatinga, Cerrado, Pantanal
25.		<i>Abrus fruticulosus</i> Wight & Arn.	Amazon Rainforest, Cerrado
26.		<i>Aeschynomene brasiliiana</i> (Poir.) DC.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pantanal
27.		PAPILIONOIDEAE	<i>Aeschynomene histrix</i> Poir.
28.		<i>Aeschynomene paniculata</i> Willd. ex Vogel	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pantanal
29.		<i>Aeschynomene viscidula</i> Michx.	Caatinga, Cerrado, Atlantic Rainforest
30.		<i>Centrosema brasiliiana</i> (L.) Benth.	Amazônia, Caatinga, Cerrado, Atlantic Rainforest, Pantanal
31.		<i>Clitoria guianensis</i> (Aubl.) Benth.	Amazon Rainforest, Caatinga, Cerrado, Atlantic

		Rainforest, Pantanal
32.	<i>Crotalaria retusa</i> L.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pampa.
33.	<i>Crotalaria stipularia</i> Desv.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pantanal
34.	<i>Desmodium barbatum</i> (L.) Benth.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pampa, Pantanal
35.	<i>Desmodium incanum</i> (Sw.) DC.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pampa, Pantanal
36.	<i>Desmodium subsecundum</i> Vogel.	Amazon Rainforest, Cerrado, Atlantic Rainforest
37.	<i>Dioclea bicolor</i> Benth.	Amazon Rainforest, Caatinga, Cerrado
38.	<i>Galactia jussiaeana</i> Kunth.	Amazon Rainforest, Caatinga, Cerrado
39.	<i>Indigofera suffruticosa</i> Mill.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
40.	<i>Macropodium atropurpureum</i> (Sessé & Moc. ex DC.) Urb.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pantanal
41.	<i>Macropodium lathyroides</i> (L.) Urb.	Amazon Rainforest, Cerrado, Atlantic Rainforest, Pantanal
42.	<i>Periandra heterophylla</i> Benth.	Amazon Rainforest, Cerrado
43.	<i>Phaseolus vulgaris</i> L.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest
44.	<i>Stylosanthes viscosa</i> (L.) Sw.	Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest, Pampa, Pantanal
45.	<i>Vigna lasiocarpa</i> (Mart. ex Benth.) Verdc.	Amazon Rainforest, Cerrado, Atlantic Rainforest, Pantanal

Key of Subfamily Caesalpinioideae

1. Herbs, shrub or tree with leaves always bipinnate with inflorescence of the glomerulus or raceme type.....2
 2. Trees with more than 10 m, always woody stem.....3
 3. Puberulent rusty branches, a lower crown, 30-45 leaflets per leaf, the apex of the rounded leaflet, a leaflet with 0.4 x 0.1 cm1 *Stryphnodendron adstrigens*
 3. Grayish, not pubertal branches, high crown, 35-50 leaflets per leaf, the apex of the acute leaflet, a leaflet with 0.6 x 0.2 cm2 *Parkia platycephala*
 2. Herbs or sub-shrub less than 10 m high, woody or herbaceous stem.....4
 4. Individuals < 1m in height, small leaflets < 1cm and < 0.5cm in width.....5
 5. Symmetrical lanceolate leaflets, dry fruit type crusty, 1.5 cm x 0.3 cm3 *Mimosa pudica*
 5. Leaflets oblong-lanceolate, fruit vegetable dry with indumentum, indiscriminate, with 9 x 0.3cm.....4 *Mimosa xanthocentra*
 4. Individuals > 1m, large leaflets larger > 1cm and > 0.5cm of width 6
 6. Leaflets tetrafoliolates, asymmetric, 2 pairs of leaflets for leaf, dry fruit of the type craspedium, with approximately 2,5x 0.3 cm.....5 *Mimosa sensitiva*
 6. Leaflets bipinnates, symmetrical, with 6-12 pairs of leaflets per leaf, legume fruit, with 5x0.3cm6 *Mimosa caesalpiniiifolia*
1. Herb, shrub, or trees with leaves bipinnates or imparipinnates with inflorescences type raceme, never glomerulus.....7
 7. Tree or shrub, with woody stem.....8

8. Trees with pubertal branches.....9
9. Stipules rudimentary or without the presence of nectary, fruit of the legume type with falcate apex.....7*Cenostigma macrophyllum*
9. Sticks not rudimentary or with the presence of nectary, legume fruit without falcate apex.....10
10. Winged petiole with petiole nectary.....11
11. Nectary greater than 2mm rounded longitudinal at the base of the rachis petioles.....8*Inga edulis*
11. Nectary less than 2mm rounded not longitudinal at the base of the rachis petiole.....9*Inga thibaudiana*
10. Absence of winged petiole, absence of nectary petiole.....12
12. Presence of long stipules in the shape of an orange sickle, with leaflets 10 x4.2 cm10*Senna reticulata*
12. Presence of small elongated stipules, leaflets 6.7 x2.6 cm11*Senna multijuga*
8. Trees with glabrous branches a little puberulent.....13
13. Inflorescence raceme with red or yellow flowers.....14
14. Flowers with red petals, lush banner, legume with 10 cm.....12*Delonix regia*
14. Flowers with yellow petals with reddish banner.....13*Libidibia ferrea*
13. Inflorescence not raceme with green or white flowers.....15
15. Inflorescence with >10 racemes, green with the presence of stamens and staminoids.....14*Dimorphandra gardneriana*
15. Inflorescence with <10 racemes, white without the presence of stamens and staminoids.....15*Plathymenia reticulata*
7. Subshrub or grass herb.....16
16. Presence of aculeus in the branches, showy red flowers, legume fruit with long apex.....16*Caesalpinia pulcherrima*
16. Absence of aculeus in the branches, exuberant flowers, legume fruit without long apex.....17
17. Prostrate growth, bipinnate leaves, legume fruit with 2-3 items.....17*Chamaecrista nictitans*
17. Growth creep or erect decumbent, bifoliolate leaves, legume fruit >3 items.....19
18. Creeping growth leaflets 3.2 x 3 cm, linear fruit with 2.2 cm and fruit petiole extended with 1.5 cm.....18*Chamaecrista rotundifolia*
18. Decumbent erect growth, leaflets with 4 x 1.2 cm, a linear legume fruit type of 4.5 cm with fruit petiole not very extended with 0.5 cm19*Chamaecrista flexuosa*

Description of Subfamily Caesalpinioideae

1. *Stryphnodendron adstringens* (Mart.) Coville (Century Dict.) 11: 111, 1910.

Description: Tree with woody trunk fissured with approximately 10 m of height, sympodial growth, branches blackish parts, absence of stipules, inermis, cylindrical, glabrescent branches, glandular trichomes in the branches with 0.3 x 0.4 cm, inches composites bipinnate leaves, alternating between 5.5 x 0.3 cm, deciduous, presence of 30-45 pairs of leaflets, leaflets with 0.4 x 0.1 cm, rounded apex, smooth margin, parallel-nerved vein, absent flower, absent fruit. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23/VI/17, G. S. GOMES; G. M. CONCEIÇÃO, 43 (HABIT).

2. *Parkia platycephala* Benth. J. Bot. (Hooker) 4 (30): 329, 1841.

Description: Tree with woody stem, sympodial growth of tall crown with 15 m, grayish branches, abstract stipules, composite bipinnate leaves, presence of 35-50 pairs of leaflets, spiral alternate phyllotaxy, diminutive lanceolate leaflets, 6 x 0.2 cm, petiole with 7 cm, long leaves with 19.5 cm showing pulvinus, whole margin, acute leaf apex, penninerved vein, cuminous inflorescence, dry fruit type legume, with 10 x 2.5 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 4 (HABIT).

3. *Mimosa pudica* L. Gard. Dict. (Ed. 8) no. 4, 1768.

Description: Shrub with woody stem, 20 cm, aculeous in the form of sickle with 0,5 0.2 cm long, bipinnates composites leaves with 6-10 pairs of leaflets, 3,2 cm pinnae, phyllotaxy alternate distal, lanceolate leaflet, with 0.9 x 0.2 cm, 2.3 cm petiole, 3.9 cm leaf, whole margin, lanceolate leaf apex, paraleinnerved vein, glomerulus cymose inflorescence, dichlamydeous, heterochlamydeous, zygomorphic symmetry, polystemonous free stamens, pink color, fruit legume craspedium type, 1.5 cm long and 0.3 cm .

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO 42 (HABIT).

4. *Mimosa xanthocentra* Mart. Flora 21 (2, Biebl.): 50.1838.

Description: Subshrub with approximately 60 cm, woody stem, prostrate sympodial growth, inermous, cylindrical branches, aculeous of 0,2 x 0.2 cm, on the stem; stipules with 0.3 x 0.2 cm, triangular, alternate composite sheets with 2 x 0.4 cm, bipinnates, with 10-5 pairs of leaflets, petioles 0.2 cm, absent extraphleic nectaries; leaflets 0.7 x 0.4 cm, oblong-lanceolate, flower absent, legume fruit with indumentum, indescend, with 9 x 0.3 cm.

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 41 (HABIT).

5. *Mimosa Sensitiva* L. Sp. Pl. 1: 518, 1753.

Description: Shrub with 2 m, branched sympodial growth, woody stem, rudimentary aculeous branches present in every branch of the shrub with 0.2 x 0.1 cm, greenish branches, tetrafoliolate composites leaves, alternate phyllotaxy, asymmetrical leaflets, unbalanced, 2.6 x 1.0 cm, petiole with 3.0 x 5.6 cm, whole leaf margin, acute leaf apex, penninerved vein, cymose , spiky, white, flower absent, fruit craspedium type, with approximately 2,5 x 0.3 cm.

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 15, 39 (HABIT).

6. *Mimosa caesalpiniiifolia* Benth. (J. Bot. (Hooker) 4 (31): 392, 1841.

Description: Shrub with woody stem, with 3m, branched sympodial growth, prostrate, grayish branches to blackened form embira, aculeous in sickle were present with 0.8 x 0.2 cm. bipinnates composite leaves with 6-12 pairs of pinnae, alternate phyllotaxy, ovate leaflet, 2.6 x 1.6 cm, petiole with 0.2 cm, leaf approximately 8.0 cm,

whole margin, rounded leaf apex, penninerved grove, cumin-shaped, spiky inflorescence, white coloring, absent flower, legume fruit, with 5 x 0.3 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 13, 14 (HABIT). **Geographical Distribution:** North (Amazonas, Pará, Rondônia); Northeast (Alagoas, Bahia, Ceará, Maranhão, Paraíba, Pernambuco, Piauí, Rio Grande do Norte); Center-West (Federal District, Goiás, Mato Grosso do Sul); Southeast (Espírito Santo, Minas Gerais, Rio de Janeiro, São Paulo); South (Paraná, Santa Catarina) (FLORA DO BRASIL 2020. 2019). **Phytogeographical Domain:** Amazon Rainforest, Caatinga, Cerrado, Atlantic Rainforest (FLORA DO BRASIL 2020. 2019).

7. *Cenostigma macrophyllum* Tul. Ann. Sci. Nat., Bot., Ser. 2, 20: 141, pl. 3, 1843.

Description: Tree with woody stem with approximately 10m of height, sympodial growth; rudimentary stipules present with 0.3 cm , with puberulent garments; petiole with approximately 3.0 x 0.4 cm; bipinnates composite leaves with 5-8 pairs of leaflets, alternate phyllotaxy, absence of nectaries, 13 cm; ovate leaflets, 9.7 x 2.6 cm, whole leaf margin, mucronate leaf apex; flower absent and cymose inflorescence with floral buds with 0.9 cm of ; fruit of the fallow legume type, 12.7 x 1.2 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 27 (HABIT).

8. *Inga edulis* Mart. Flora 20 (2, Beibl.): 113-114, 1837.

Description: Trees of 7 m, sympodial growth of low branch, woody stem, branches with attached structures, tomentose stipules, cylindrical pebbles of 0,2 x 0,2 cm. winged deciduous, bipinnates composite leaves, with 3-8 pairs of leaflets, smooth margin, acute apex, penninerved vein, petioles with 0.4 x 0.2cm, petiolate with 13.5 x 8 cm. winged leaf 4.6 cm, nectary leaves of 0.1 cm. an d 0.1 of width. broad, concave, sessile in the circular shaped stem, absent flowers, and absent fruits. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 37, 38 (HABIT).

9. *Senna reticulata* (Willd.) H. S. Irwin & Barneby. Mem. New York Bot. Gard. 35: 458, 1982.

Description: Tree with woody stem, approximately 5m high, sympodial growth, puberulent blackish branches, sickle type stipules, orange, present with 0.8 x 0.3 cm,

composite leaves with 15-20 pairs of pinnae, spiral alternating phyllotaxy, oblong leaflets, 10 cm and 4.2 cm, petiole with 4.5 cm, leaf with approximately 18 cm, whole margin with emarginated leaf apex, penninerved vein, raceme inflorescence with several racemes produced, dioecious, complete, heterochlamydeous, dialystemonous, free stamens, fruit dehiscent legume, with 14 x 2.2 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Serra do Cajuí Village, 14 / II / 17, G. S. GOMES; G. M. CONCEIÇÃO, 22 (HABIT).

10. *Senna multijuga* (Rich.) H.S. Irwin & Barneby Mem. New York Bot. Gard. 35: 492, 1982.

Description: Tree with woody stem, 7m high with sympodial growth, with grayish parts about 10m, grayish branches, composite leaves, 8-12 pairs of pinnae, petiole with up to 2 cm of, and 0.9 cm, leaflets of 6.7 x 2.6 cm. petiolate, oblong, glabrous or puberulent tops, nectary 0.2 cm, the raceme spinal cord at the base of the petiole in the first jug; canaliculate petiole with 0.2 x 0.1, yellow dioecious flower, complete (sepals and petals), dichlamydeous, heterochlamydeous, dialystemonous, free stamens, absent fruit. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 25, 26 (HABIT).

11. *Dimorphandra gardneriana* Tul. Arch. Mus. Hist. Nat., 4: 185, 1844.

Description: Tree with stem trunk with 12m long, sympodial growth, woody stem, shape embira, obtipate stipules, composite leaves with 30 x 14 cm, bipinnates, opposite phyllotaxy, oblong leaflet shape, with 1.8 x 1.0 cm, presents about 15-25 pairs of leaflet, whole leaf margin, rounded leaf apex, truncated base, diminutive petiole with approximately 0.2 cm of, raceme inflorescence, with approximately 10 racemes, with approximately 10 x 3 cm, shows a light greenish color with a crescent, showing stamens and tiny staminoids, absent fruit. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 32, 33 (HABIT).

12. *Plathymania reticulata* Benth. J. Bot. (Hooker) 4 (30): 334, 1841.

Description: Tree with woody stem, sympodial growth, 12 m, form embira, abstract stipules, absent nectary, leaves composed of approximately 20-30 pairs of leaflets, bipinnates with pulvinus, alternate Phyllotaxy, oblong

leaflet, 2 x 0.6 cm, petiole with 3.0 cm, long leaves with 14 cm, whole margin, emarginated leaf apex, penninerved vein, raceme inflorescence approximately 4 x 0.3 cm, single racemes, miniature white flowers, absent fruit.

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area; Redondo Village; Populated Stones, 08 / X / 16; 13 / II / 2016; 23 / VI / 2017, G. S. GOMES; G. M. CONCEIÇÃO, 16, 24, 68 (HABIT).

13. *Delonix regia* (Bojer ex Hook.) Raf. Fl. Tellur. 2: 92, 1836 [1837].

Description: Tree with sympodial growth, woody stem, approximately 15m, shape embira, obtipate stipules, composite bipinnates leaves with 30 x 15 cm, alternate Phyllotaxy, oblong leaflet shape, with 30-50 pairs of leaflets, with 0.7 x 0.2 cm, rounded apex, smooth margin, symmetrical base, petiole with 2.5 x 0.4 cm, petiole with 0.3 x 0.1 cm, absent flower, fruit of the dehiscent type, with 15 x 3 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 40 (HABIT).

14. *Libidibia ferrea* (Mart. Ex Tul.) LP Queiroz Legum. Caatinga 130, 2009.

Description: Tree with woody stem, 5m high, sympodial growth, absent stipules, puberulent branches rusty, bipinnates composite leaves with approximately 10-15 pairs of leaflets, alternate phyllotaxy, leaflets oblong, with 3.6 x 1.0 cm, petiole with 1.1 x 0.3 cm, leaf with approximately 6.5 cm, whole leaf margin, rounded leaf apex, penninerved vein, glabrous leaflets, indeterminate inflorescence, flower with approximately 1.0 x 0.5 cm, yellow flowers, complete, dichlamydeous, heterochlamydeous, showy standard, dialystemonous, legume fruit dry type, with 7.3 x 2.0 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 28, 29, 30 (HABIT).

15. *Caesalpinia pulcherrima* (L.) Sw. Observ. Bot. 166, 1791.

Description: Woody trunk tree, 4 m, shows sympodial growth, presence of aculeus in the trunk with 0.4 x 0.2 cm, composite leaves bipinnates with 5 pairs of pinnae, 30 cm, phyllotaxy alternates, without stipules, petiole with 0.5 x 0.3 cm, green leaflets of 7-11 pairs, with 6.1 x 3.4 cm, red flower with long stamens of 4 cm. zygomorphic symmetry. legume fruit dry type with 9.3 x 2.5 cm. **Material Examined:** BRAZIL. MARANHÃO:

São João do Sóter, Pedras Village, 13 / II / 17, G. S. GOMES; G. M. CONCEIÇÃO, 31 (HABIT).

16. *Inga thibaudiana* DC. Prodr. 2: 434-435, 1825.

Description: Shrub with 3 m, woody stem, sympodial growth, with cylindrical root, presents indumentum in the branches, form embira, compound leaves with 11,1 x 9.5 cm, with 3 to 8 pairs of leaflets, alternating leaflets with 4.9 x 3.8 cm. The larvae are broad and narrow in the abaxial surface, with a smooth margin, penninerved vein, petiole with tiny extraphalic nectaries, at the base of the leaflets, with a rounded nectary, fruit absent. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 34, 35 (HABIT).

17. *Chamaecrista nictitans* (L.) Moench. Methodus 272, 1794.

Description: Herb with approximately 40 cm, herbaceous stem, prostrate growth, branches of 28 x 16.5 cm. stipules on the petiole with approximately 0.4 x 1 cm. composite leaves, bipinnates, oblong leaflets of approximately 0.1 x 0.1 cm. rachis with 0.3 cm. absent flower and legume fruit with 3.5 x 0.3 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 58 (HABIT).

18. *Chamaecrista rotundifolia* (Pers.) Greene. Pittonia 4 (20D): 31, 1899.

Key of Subfamily Cercidoideae

- 1 Grass or shrubs with grampiform branches scandante, single leaves with split limb.....**1Phanera variegata**
 1 Grass, shrub or tree without grampiform branches, single leaves with or without split limb..... 2
 2. Bilobed simple leaf, small 3.5 cm, 2.6 cm, legume fruit type, 6 cm long, 2 cm**2Bauhinia pulchella**
 2. Single cordiform leaf, uncut in limbus, large 7.5 x4.3 cm; legume fruit with 14,5 x 1,5cm**3Bauhinia dubia**

Description of Subfamily Cercidoideae

1. *Phanera variegata* (L.) Benth. Pl. Jungh. 2: 262, 1852.

Description: Shrub with approximately 2 m, sympodial growth, woody stem, blackened branches, leaves with tinystipules to absent, single leaves with 7,0 x 4.6 cm, bilobate simple leaflets, rounded apex, petiole with 4.3 cm x 0.8 cm phyllotaxy alternate, vein cunninerved, absence of nectarines, presence of grampiform branches, scandants with approximately 6x 0.3 cm, absent flower and absent fruits. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area; Redondo Village; Pedras Village, 08 / X / 16; 13 /

II / 2016; 23 / VI / 2017, G. S. GOMES; G. M. CONCEIÇÃO, 2, 3, 20, 21, 36 (HABIT).

Description: Herb stem, triangular stipules present with 0.1 x 0.2 cm. bifoliate composite leaves, alternate phyllotaxy, 3.2 cm obovate leaf, and 3 cm, whole leaf margin, obtuse apex, yellow zygomorphic flower, achlamydeous, legume fruit dry type with 2.2 cm and fruit petiole extended with 1.5 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 66 (HABIT).

19. *Chamaecrista flexuosa* (L.) Greene Pittonia 4 (20D): 27, 1899.

Description: Shrubs with woody stem, erect to decumbent growth, approximately 20 cm, perennial, erect, with triangular stipules of 5 x 3.2 cm, bilobate leaves with 4cm of. leaflets, with 5 to 10 pairs, with 4 x 1,2 cm long, extrafollicular nectary leaflets linear-lanceolate to linear-oblong or closely oblong-elliptic, straight to slightly distally falcate, persistent, heteromorphic and asymmetric stipules, lanceolate acuminate or ovate-acuminate, absent flower, legume fruit with 4.5 x 0.5 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 48, 49, 50 (HABIT).

2. *Bauhinia pulchella* Benth. Fl. Bras. 15 (2): 190, 1870.

Description: Shrub with woody stem, approximately 3m, with sympodial growth, presents rudimentary stipules with 0.3cm of, branches glabrous; petiole with 0.6 x 0.2 cm, single sheets, 6.0 x4.3 cm, spiral alternating phyllotaxy, absence of nectary; leaflet with bilobate limb, 3.5 x 2.6 cm, whole margin, rounded leaf apex; inflorescence cyanotic, monoecious, dichlamydeous, heterochlamydeous, zygomorphic, calice gamosepalous, with 1.0cm, glabrous, linear peduncle; corolla linear dialypetalous with 1,5 x 2,5 cm, free stamens; dried legume fruit type, with 6,0 x 2,0 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Redondo Village, 13 / II / 17, G. S. GOMES; G. M. CONCEIÇÃO, 17 (HABIT).

3. *Bauhinia dubia* G. Don Gen. Hist. 2: 463, 1832.

Description: Shrub with woody stem of sympodial growth with approximately 3m, rudimentary stipules present with 0.2 cm; glabrous branch; petiole of 4 cm long and 0.2 cm; sheet 7.5 x 4.3 cm width, alternate phyllotaxy, absence of nectaries; simple leaflets

cordiform to sagittate, 3.4 x 3.6 cm, cm, whole leaf margin, rounded apex; inflorescence raceme; floral bud with 0.8 x 2.5 cm, dried fruit, dehiscent legume type with 14.5 x 1.5 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Village Redondo 13 / II / 17, G. S. GOMES; G. M. CONCEIÇÃO, 23 (HABIT).

Key of Subfamily Detarioideae

1. Composite bipinnates leaves, presents 28 to 40 pairs of leaflets, alternating phyllotaxy.....1*Tamarindus indica*
1. Composite bifoliolate leaves, not dystonic alternate phyllotaxy.....2*Hymenaea stigonocarpa*

1. *Tamarindus indica* L. (Sp. Pl.)1: 34, 1753.

Description: Tree with 12 m, woody stem, symmetrical growth, high crown, brownish branches, rudimentary stipules present with 0.2 cm, composite leaves bipinnates, presents 28 to 40 pairs of leaflets, oblong leaflet with 1.0 x 0.3 cm, petiole with 3.0 cm leaf with approximately 8.0 cm, whole leaf margin, rounded leaf apex, paraleinnerved vein, flower absent, absent fruit. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 5 (HABIT).

Description: Tree with 15m height, woody stem, elongated sympodial growth, glabrous branches, bifoliolate composite leaves, alternate phyllotaxy, asymmetrical leaflet form ovate, without indumentum, leaflet with 11 x 5cm, petiole with 2.0 cm, leaf with 8.0 cm, presence of leaf blade limbs, whole margin, emarginated leaf apex, penninerved veins to cunninerved, absent flower, legume fruit dry type, with approximately 7.0 x 4 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Redondo Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 19 (HABIT).

2. *Hymenaea stigonocarpa* Mart. Getreue Darstell. Gew. 11: sub pl. 13, 1830.

Key of Subfamily Papilionoideae

1. Liana, fruit type vegetable with 3 seeds, without forming of articles, with 4 cm, margin revolute of legume.....1*Dioclea bicolor*
1. Herb or Subshrub, legume fruit with 3 more seeds or with the formation of articles, without revolute margin..... 2
2. Subshrub with height equal to or greater than 1m, only erect growth3
 3. Composite leaves imparipinnates, with 8 to 12 pairs of leaflets, fruit legume type curved, forming in bunches in the main branch, with 8,0 cm of2*Indigoferasuffruticosa*
 3. Leaves simple or trifoliolate, fruit legume lomentum type, not form clusters in the main branch..... 4
 4. Leaves simple large ovate, with 20 x 10 cm long, long fruit forming branches, arranged alternately.....3*Desmodium subsecundum*
 4. Small trifoliolate leaves, small fruit forming branches, arranged not alternate leaves form.....5
 5. Elliptic leaflets, 2.4 x 1.1 cm, fruit type lomentum, 1.1 cm, with 3-5 articles.....4*Desmodium incanum*
 5. Elliptic leaflets, 7 x 3.6 cm, fruit type lomentum, 3.3 x 0.8 cm, has 3-6 items dressed.....5*Desmodium barbatum*
2. Climbing or herbaceous herb with height equal to or >1,5m, erect, decumbent or prostrate growth.....6
6. Decoding growth climbing herbs.....7
 7. Leaves composed of 8-15 pairs of leaflets, bipinnates with 2.3 x 0.9 cm, pseudo-raceme inflorescence.....6*Abrus fruticulosus*
 7. Leaves trifoliolate, inflorescence raceme or cymose, not raceme.....8
 8. Long lanceolate leaflet..... 9

9. Leaflet with 5,2 x 3 cm long, papilionaceous flower, lilac dark to purple petals.....**7***Centrosema brasiliana*
9. Leaflets with 5,0 x 1,0 cm, papilionaceous flower petals light to whitish lilac.....**8***Clitoria guianensis*
8. Leaflets ovate or obovate..... 10
10. Leaflets ovate, with 10 x 6.1 cm, mucronate leaf apex, marked penninerved vein, red papilionaceous flower.....**9** *Periandra heterophylla*
10. Leaflets obovate 4.5 x 3 cm, acute leaf apex, unmarked penninerved vein, yellow papilionaceous flower.....**10***Vigna lasiocarpa*
6. Herbaceous herb of erect or prostrate growth..... 11
11. Simple leaves, legume fruit capsule type 12
12. Leaflet with 4.7 cm. and 2.0 cm long, winged petiole with 0.3 cm, fruit with 2.3 cm**11** *Crotalaria stipularia*
12. Leaflet with 4,2 x 1.5cm, not winged petiole with 0.3 cm, fruit with 3.0 cm**12***Crotalaria retusa*
11. Composite leaves, typical legume fruit or lomentum..... 13
13. Compound leaves bipinnates, legume lomentum..... 14
14. Leaflets with up to 6 pairs of pinnas, equal to or < 0,5cm, lomentum with up to 3 articles.....**13***Aeschynomene viscidula*
14. Leaflets with more than 6 pairs of pinnas, > 0.5 cm long, legume lomentum with more than 3 articles..... 15
15. Leaflets of the base of the pinna bigger than the apex, obovate, with a maximum of 12 pairs of pinnas.....**14***Aeschynomene brasiliana*
15. Leaflets of the base never greater than the one of the apex, oblong, with the maximum of more than 12 pairs of pinnas 16
16. Leaflets with 7,0 x 0.2 cm, apex acuminate, legume with up to 7 articles.....**15***Aeschynomene histrix*
16. Leaflets 1.0 cm long, 0.3 cm, rounded leaf apex, legume with up to 5 articles.....**16***Aeschynomene paniculata*
13. Composite leaves trifoliolate, fruit legume type..... 17
17. Leaf lobes lateral, leaflet equal to or > 4cm 18
18. Leaflets with 8cm, truncated rachis**17***Phaseolus vulgaris*
18. Leaflets, 4 cm, not truncated rachis..... 19
19. Lateral leaflets with diminutive petiole to sessile, fruit legume type with 6 cm, indehiscent.....**18***Macroptilium atropurpureum*
19. Side leaflets with elongated petiole, fruit legume type with 5.6cm of**19***Macroptilium lathyroides*
17. Not lobulated lateral leaflets, leaflet smaller than 4cm 20
20. Leaf apex emarginate, leaflet with 3x1.7cm.....**20***Galactia jussiaeana*
20. Acute leaf apex, a leaflet with 1.9 x 0.6cm, elliptical.....**21***Stylosanthes viscosa*

1. *Dioclea bicolor* Benth. (Comm. Legum. Gen.) 69, 1837.

Description: Liana with woody stem, presents approximately 2 m, erect growth, shape embira, present linear stipules with 0.6 cm, trifoliolate composite leaves, deistical alternate phyllotaxy, large oblong lanceolate leaflet with 8, 4 cm long and 5.0 cm, petiole with 4.6 cm, and leaf with approximately 13.1 cm, whole leaf margin, rounded leaf apex, penninerved vein, raceme inflorescence, fruit legume type, with 4 cm long, ridge,

hairy, with 2 to 5 seeds. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 10 (HABIT).

2. *Indigofera suffruticosa* Mill. Gard. Dict. (Ed. 8) *Indigofera* no. 2, 1768.

Description: Shrub with woody stem, 2m long, symmetrical erect growth, present linear stipules with 0.5 cm, unequipped composite leaves, with 8-12 pairs of

leaflets, alternate phyllotaxy, lanceolate-oblong leaflet, with 3.0 x 1.2 cm, petiole with 2.0 cm, leaf 9.3 cm, crenellated leaf margin, mucronate leaf apex, penninerved vein, symmetric leaflet, raceme Inflorescence, curved legume type dry fruit, forming in bunches in the main branch, with 8.0 cm, fruit with 1.5 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO 56 (HABIT).

3. *Desmodium subsecundum* Vogel. (Linnaea) 12: 99, 1838.

Description: Subshrub with approximately 1 m of height, erect growth, woody stem, triangular stipules with approximately 0.4 x 0.1 cm, single large ovate leaves with some 3.4 x 2 cm. others with 20 x 10 cm, trichomes on the stem of approximately 0.1 x 0.1 long, rather, 3 cm petiole. and 0.4 cm. rachis with 0.4 cm. whole margin, rounded apex, ovate leaflet, symmetrical, penninerved vein, absent flower, fruit legume type of approximately 0.1 x 0.1 cm. arranged alternately no petiole, having 3-5 articles with adherent trichomes. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 65 (HABIT).

4. *Desmodium incanum* (Sw.) DC. Prodr. 2: 332, 1825.

Description: Herbaceous subshrub, decumbent erect growth, is approximately 1m, triangular stipules present with 0.6 cm, basis of the petiole, composite trifoliolate leaf, alternating phyllotaxy, elliptic leaflets, 2.4 x 1.1 cm, 1.5 cm petiole, approximately 4.0 cm, leaf, whole leaf margin, apex rounded, symmetrical, penninerved vein, presence of trichomes, medium pilosity, inflorescence raceme, absent flower, dry fruit lomentum type, with 1,1 cm. Possessing 3-5 articles with adherent trichomes. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 51, 52 (HABIT).

5. *Desmodium barbatum* (L.) Benth. Vidensk. Meddel. Dansk Naturhist. Foren. Kjøbenhavn 1853 (1-2): 18, 1853.

Description: Subshrub with 80 cm, woody stem, erect growth, triangular stipules present with 0.6 cm, composite leaves trifoliolates, phyllotaxy distal alternate, leaflets elliptic symmetrical, with 7 x 3,6 cm of width, petiole with 1.5 cm, leaf with approximately 4.0 cm, whole leaf margin, rounded apex, hairiness with whitish trichomes,

penninerved vein, raceme inflorescence, absent flower, dried fruit lomentum type, 3 x 0.8 cm, 3-6 items, clingy.

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 67 (HABIT).

6. *Abrus fruticulosus* Wight & Arn. (Prod. Fl. Ind. Orient.) 1: 236, 1834.

Description: Herb with approximately 1 m, with herbaceous stem, indumentum in the present branch. Persistent, tiny linear stipules at the base of the petiole, petiole with 3.5 x 2 cm; leaves composed of 8-15 pairs of leaflets, bipinnates with 2.3 x 0.9 cm, obovate, linear leaflets; legume, rounded apex, symmetrical limbus, Inflorescence: position of the pseudo-raceme inflorescence, flower absent, typical fruit with 3.5 x 1 cm. apex sharp to curved. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 57 (HABIT).

7. *Centrosema brasiliana* (L.) Benth. Comm. Legum. Gen. 54, 1837.

Description: Herb, herbaceous stem, approximately 1.5 m, presents triangular ocrea stipules at the base of the petiole of 0.3x0.2 cm, trifoliolate composite leaves, with an opposite pair at the base and one elongated by the rachis, 7 cm long leaf, alternate phyllotaxy, leaflets 5.2 x 3 cm lanceolate to linear, smooth margin, acute apex, penninerved vein, little evident trichomes, papilionaceous flower, purple petals, with heterochlamydeous axillary inflorescence, dichlamydeous, dialystemonous, complete, typical legume fruit 7,0 x 0.4 cm, linear. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area; Populated Stones, 08 / X / 16; 23 / VI / 2017, G. S. GOMES; G. M. CONCEIÇÃO, 9, 44, 45 (HABIT).

8. *Clitoria guianensis* (Aubl.) Benth. J. Proc. Linn. Soc., Bot. 2: 40, 1858.

Description: Herb, approximately 50 cm, herbaceous stem, ovate stipules, striated, at the base of the petiole with 0.3 x 0.1 cm, composite leaf trifoliolate with 5 x 1 cm, lanceolate leaflet, alternates phyllotaxy, acute apex, penninerved veins, symmetric, present trichomes, axillary inflorescence, flower, monoecious, subsessile; long tubular calyx whitish, striated, papilionaceous corolla, unguiculated petals, lilac, orbicular banner, lato; free wings, obovate, keel falcated, lato unguiculate, heterochlamydeous, dichlamydeous, dialystemonous, absent fruit. **Material Examined:** BRAZIL.

MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 60 (HABIT).

9. *Periandra heterophylla* Benth. (Comm. Legum. Gen.) 57,1837.

Description: Herbaceous, climbing vine, 1.20 m, decumbent erect growth, presence of linear stipules with 0.4 cm of , absence of nectary, composite leaves, trifoliolate, alternate , leaflet ovate-lanceolate, 10 x 6.1 cm , petiole with 5.0 cm, leaf with approximately 8.0 cm, whole margin, mucronate leaf apex, marked penninerved vein, symmetrical leaflet, presence of trichomes in leaflets and aramos, homogeneous pilosity, cymose inflorescence with 0.8 cm of , flower absent, fruit absent. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 53 (HABIT).

10. *Vigna lasiocarpa* (Mart.ex Benth.) Verdc. (Kew Bull.) 24 (3): 539.1970.

Description: Herb with approximately 30 cm, erect decumbent growth, herbaceous stem, greenish branches, triangular stipules 0,3x 0,1 cm at the base of the petiole. Leaves composite trifoliolate, alternate, adaxial structure with secondary penninerved vein marked in leaflets, leaflets obovate with 4.5 x 3 cm, acute leaf apex, petiole with 4 x 0,1 cm, full margin, symmetrical, presence of trichomes in leaflets, Inflorescence raceme, axial, yellow flower, zygomorph, achlamydeous, papilionaceous, dry fruit of the long legume type with 3 x 0.2 cm . with trichomes. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 63 (HABIT).

11. *Crotalaria stipularia* Desv. J. Bot. Agric. 3: 76, 1814.

Description: Herb stem-like stem herb, decumbent erect growth, 65cm long, linear stipules present with 0.3 x 0.1 cm, nectaries absent, single leaves, alternate phyllotaxy, leaflets oblong-lanceolate, with 4,7 x 2,0 cm, winged petiole with 0.3 cm, leaf approximately 5.1 x 3 cm , leaf margin whole, apex emarginate, penninerved vein, symmetric, presence of white trichomes, quite hairy, yellow papilionaceous flower with 0.3 x 0.3 inches. with zygomorphic symmetry inflorescence cymose, heterochlamydeous, dichlamydeous, dialystemonous, dry fruit, capsule, with approximately 2.3 cm. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 47 (HABIT). 12.

12. *Crotalaria retusa* L. Sp. Pl. 2: 715, 1753.

Description: Herb stem-type herb, 50 cm high, decumbent erect growth, linear stipules present with 0.4 cm of , absent nectaries, single leaves, alternate phyllotaxy, obovate leaflets, 4.2 cm, bought 1.5 x 0.3 cm petiole, 4.6 cm long leaf and 4 cm , whole leaf margin, emarginated apex, penninerved vein, cuminous inflorescence, absent flower, dried fruit, capsule, with approximately 3.0 cm of , and 0.8 cm . with legume acute terminal. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 12 (HABIT).

13. *Aeschynomene viscidula* Mich. Fl. Bor.-Amer. 2: 74-75, 1803.

Description: Herb with approximately 50 cm of height, herbaceous stem, prostrate growth, branches with 32 x 19 cm, triangular stipules with 0.4 x 0.2cm, is found at the base of the petiole, composites bipinnates leaves, with 3-pairs of leaflets, leaflet with 1.7 x 1 cm , petiole 0.5 x 0.1 cm , obovate leaflets 0.5 x 0.6 cm , trichomes, flower with campanulate calyx, papilionaceous, yellow cream, showy standard, heterochlamydeous, dialystemonous, dialypetalous, Fruit type lomentum legume, with articles joined by isthmus with 1 x 0.3 cm , features 3 hairpieces. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 59 (HABIT).

14. *Aeschynomene brasiliiana* (Poir.) DC. Prodr. 2: 322, 1825.

Description: Herb with approximately 50 cm, woody stem, erect growth to decumbent, branches with gray parts, triangular stipules with 1 x 0.3 cm, composite bipinnates leaves have 6 -12 pairs of leaflets, with 6 cm of , and 1.4 cm , leaflets obovate with 0.8 x 0.4 cm , leaflets of the base larger than the leaflets of the apex of the pinnas, petiole with 1 x 0.2 cm , presence of trichomes with 1 mm of , smooth margin, apex of rounded leaflet, symmetrical, with penninerved veins, inflorescence raceme, flower absent, fruit legume with 0.3 x 0.2 inches long, arranged in the petiole with 0.3 cm, 3-6 articles. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 64 (HABIT).

15. *Aeschynomene histrix* Poir. Encycl., Suppl. 4 (1): 77-78, 1816.

Description: Herb, presents on average 45 cm, erect decumbent growth, triangular stipules present with 0.3 x 0.1 cm, it presents at the base of the petiole, striated,

composite leaves bipinnates with 10-18 pairs of leaflets, alternate phyllotaxy; petiole 4 x 0.4 cm, leaflets 0.7 x 0.2 cm, opposite, oblong, whole leaf margin, apex acuminate, with whitish trichomes; flower absent; dry fruit, lomentum legume, with about 3cm . presents from 4 -7 items dressed.

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 6, 7, 8 (HABIT).

16. *Aeschynomene paniculata* Willd. ex Vogel (Linnaea) 12: 95-96, 1838.

Description: Herb, with 60 cm , decumbent erect growth, grayish branches, presence of triangular stipules with 0.1 x 0.1 cm ; garment with few whitish trichomes; 0.6cm petiole; leaves approximately 6,5 x 3 cm composed of 12-25 pairs of leaflets, bipinnates, alternating phyllotaxy, absence of nectaries; oblong leaflet, 1.0 x 0.3 , whole margin, rounded leaf apex; median leaflets larger than the base and apex, cymose inflorescence with 0.3 cm , absent flower, fruit legume lomentum with 5 articles.

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO 55 (HABIT).

17. *Phaseolus vulgaris* L. Sp. Pl. 2: 723,1753.

Description: Herb stems climbing herb, prostrate erect growth, 20cm long, greenish branches, absent stipules, trifoliolate composite leaves, alternating, leaflets with sagittarius, 8 x 4.3 cm, petiole with 0.2 x 0.1 cm, leaves 8.2 cm, whole wavy margin, penninerved vein, acute leaf apex, symmetrical, reduced pulvinus, truncated rachis, absent fruit and flower absent. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 01 (HABIT).

18. *Macroptilium atropurpureum* (Sessé & Moc. ex DC.) Urb. Symb. Antill. 9 (4): 457, 1928.

Description: Herb with approximately 60 cm, Herbaceous stem, erect decumbent growth, green branches with 21,5 cm of, and 16 cm. triangular stipules of approximately 0.2 cm, and 0.1 cm, composite leaves, alternate, trifoliolate with 6 x 4 cm, leaflets oblong-lanceolate to sagittal of 4 x 1.8cm. wavy margin, rounded apex, penninerved vein, symmetrical, slightly pilose, lobed lateral leaflets sessile and main leaflet extended by rachis, absent flower, dry fruit legume type with 6 x 0.4 cm, indecipherable. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI

/ 17, G. S. GOMES; G. M. CONCEIÇÃO, 61, 62 (HABIT).

19. *Macroptilium lathyroides* (L.) Urb. Symb. Antill. 9 (4): 457, 1928.

Description: Herb, decumbent erect growth, approximately 30cm , greenish branches, tiny triangular stipules present with 0.5 x 0.2 cm , presence of nectary rounded in the petiole, composite leaves trifoliolate, phyllotaxy distal alternate, leaflet lanceolate to linear, with 4 x 2.6 cm , petiole 5 x 7.0 cm long leaf, whole leaf margin, acute leaf apex, symmetrical, leaf apex obtuse to codiform, presence of scattered trichomes, absent flower, dry fruit type legume long, approximately 5.6cm.

Material Examined: BRAZIL. MARANHÃO: São João do Sóter, Pedras Village, 23 / VI / 17, G. S. GOMES; G. M. CONCEIÇÃO, 54 (HABIT).

20. *Galactia jussiaeana* Kunth. Mimos. 196-200, pl. 55, 1824.

Description: Herb, decumbent erect growth, 1m long, presence of triangular stipules with 0.4 cm, trifoliolate composite leaves, alternate phyllotaxy, oblong leaflets with trichomes, leaflet with 3x 1.7 cm , petiole 3.0 cm, leaf approximately 6,0 cm, whole leaf margin, emarginated leaf apex, penninerved vein, trichomes on leaflets and branches, hairiness, symmetrical leaflet, absent flower, fruit dry legume type with 6x 0.3 cm , terminal apex of falcate fruit. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Serra do Cajuí Village, 14 / II / 17, G. S. GOMES; G. M. CONCEIÇÃO, 18 (HABIT).

21. *Stylosanthes viscosa* (L.) Sw. Prodr. 108,1788.

Description: Herb, 30 cm, decumbent erect growth, greenish branches, with triangular stipules of 0.5 cm , at the base of the petiole, composite leaves trifoliolate, phyllotaxy distal alternate, leaflets elliptical, with 1.9 x 0.6 cm, petiole with 0.5 x 0.2 cm , leaf with approximately 2.5 cm, whole margin, acute leaf apex, penninerved vein, presence of glandular trichomes in all branches, homogeneous pilosity, symmetrical leaflets, cymose inflorescence with 4,5 cm, dichlamydeous, heterochlamydeous, gamosepalous with 0.4., gamopetalous with zygomorphic symmetry, papilionaceous yellow flowers with, striated standard marked with red coloration, Fruit absent. **Material Examined:** BRAZIL. MARANHÃO: São João do Sóter, Permanent Protection Area, 08 / X / 16, G. S. GOMES; G. M. CONCEIÇÃO, 46 (HABIT).

IV. CONCLUSION

In this research, three new occurrences were obtained to the Maranhão with *Desmodium subsecundum* (Papilionoideae), *Aeschynomene viscidula* (Papilionoideae) and *Vigna lasiocarpa* (Papilionoideae), with *V. lasiocarpa* being a new ledger to the Northeast. This research is relevant for the Northeastern flora, through the increase of knowledge of the Leguminosae family characteristics and the expansion of the geographic distribution of the species in the region. proved to be very diverse in Cerrado Maranhense, making the work the largest survey in the family's geographical area for the State through a pioneering research for the area, building an important knowledge in the field of botanical study, thus offering taxonomic keys that will serve as recognition and identification of the species for the Cerrado of the state.

Producing taxonomic works on Leguminosae is of extreme importance, so it is possible to understand several characteristics which are still unknown. The morphological and taxonomic diversity of Leguminosae is expressed in its high number of taxa that is distributed in almost all regions of the world.

Leguminosae proved to be very diverse in Cerrado Maranhense, making the work the largest survey in the family's geographical area for the State through a pioneering research for the area, building an important knowledge in the field of botanical study, where the taxonomic keys produced will serve as recognition and identification of the species for the State Cerrado.

The importance of the research is also evidenced by providing information for the conservation and management of these new occurrences from taxonomic data. It can be mentioned that the species indexed as a new occurrence will contribute to the construction of the Brazilian Flora, through the REFLORA 2020 Project, which intends to index all Brazilian plant species until the year 2020, fortifying the data of Maranhão and the Northeast region, thus guaranteeing greater representation of Brazilian biodiversity.

REFERENCES

- [1] APG IV. (2016). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society. v.181, p. 1–20
- [2] Barneby, R. C. (1991). *Sensitiva ecensitae*: a description of the genus *Mimosa* Linnaeus (Mimosaceae) in the new world. Bronx: The New York Botanical Garden, p. 835.
- [3] Batalha, M. A. (2011) O cerrado não é um bioma. *Biota Neotropical*. v. 11, n. 1, p. 21-24.
- [4] Bentham, G. Leguminosae. In: Bentham, G.; Hooker, J. D. (1865) *Sistens dicotyledonum polypetalorum ordines XI: Leguminosae-Myrtaceaeas*. Genera Plantarum. London: Lovell Reeve e Co, v. 1, n. 2, p. 434-600.
- [5] Cronquist, A. (1981). An integrated system of classification of flowering plants. Columbia University Press, New York. p. 1262.
- [6] Domingos, A. H.; Carpelari JR, L. (2016). Plantas medicinais patas-de-vaca. Piracicaba: ESALQ - Divisão de Biblioteca, p. 32.
- [7] Fernandes, A. (1996). O taxon *Aeschynomene* no Brasil. Fortaleza, CE: Editora da UFC., 128 p.
- [8] Fidalgo, O.; Bononi, V. L. R. (1989). Técnicas de coleta, preservação e herborização do material botânico. Instituto de Botânica de São Paulo. p. 62.
- [9] Flora do Brasil. Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. Disponível em: <<http://floradobrasil.jbrj.gov.br/>>. Acesso em: 27/07/2015.
- [10] Graham, P.H.; Vance, C.P. (2003). Legumes: Importance and constraints to greater use. *Plant Physiol*. 131: 872–877.
- [11] Hutchinson, J. (1964). The genera of flowering plants. Oxford University Press, Oxford. v. 1. p. 516.
- [12] IBGE. Indicadores sociais municipais: uma análise dos resultados do universo do censo demográfico 2010. Rio de Janeiro. IBGE. p. 151, 2010. Disponível em:<http://www.ibge.gov.br/home/estatistica/populacao/censo2010/indicadores_sociais_municipais/indicadores_sociais_municipais.pdf>. Acesso em: 21/06/2017.
- [13] Isely, D. *Orbexilum*. (1990). In: *Vascular Flora Southeastern United States*. Chapel Hill: University of North Carolina Press. v. 2, p. 99–102.
- [14] Lewis, G. P. (1987). Legumes of Bahia. *Royal Botanic Gardens, Kew*. p. 369.
- [15] Lewis, G. P.; Schrire, B. D.; Mackinder, B. A.; Lock, J. M. (2005). *Legumes of the World*. Royal Botanic Gardens, Kew. p. 577.
- [16] Lima, L. C. P.; Queiroz, L. P.; Tozzi, A. M. G. A.; Lewis, G. P. A. (2014). Taxonomic Revision of *Desmodium* (Leguminosae, Papilionoideae) in Brazil. *Phytotaxa*. v. 169, p. 001–119.
- [17] Lima, L. C. P.; Oliveira, M. L. A. A. *Aeschynomene*. In: R. C. Forzza et al. Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. 2010. Disponível em: <http://floradobrasil.jbrj.gov.br/2010/FB022778> Acesso: em 20/07/2017
- [18] LPWG. Legume Phylogeny Working Group. (2017) A new subfamily classification of the Leguminosae based on a taxonomically comprehensive phylogeny. *Taxon*. v. 66, n.1, p. 44–77. Doi: <https://doi.org/10.12705/661.3>
- [19] _____. (2013) Legume Phylogeny Working Group. Legume phylogeny and classification in the 21st century: Progress, prospects and lessons for other species-rich clades. *Taxon*. v. 62, p. 217–248. Doi: <https://doi.org/10.5167/uzh-78167>
- [20] Maranhão. (2011). Plano de Ação Para Prevenção e Controle do Desmatamento e das Queimadas no Estado do

- Maranhão. Governo do Estado do Maranhão. Secretaria de Estado do Meio Ambiente e Recursos Naturais. p. 110.
- [21] Maréchal, R.; Mascherpa, J. M.; Stainier, F. (1978). Etude taxonomique d'un groupe complexe d'espèces des genres *Phaseolus* et *Vigna* Papilionaceae sur la base de données morphologiques et polliniques, traitées par l'analyse informatique. *Boissiera*. v. 28, p. 1-273.
- [22] Ormond, J. G. P. (2006). Glossário de termos usados em atividades agropecuárias, florestais e ciências ambientais. Rio de Janeiro. BNDS, p. 316.
- [23] Queiroz, L. P. (2009). Leguminosas da Caatinga. Universidade Estadual de Feira de Santana. Royal Botanic Gardens; Associação Plantas do Nordeste, p. 467.
- [24] Ribeiro, J. F. (1998). Cerrado: Matas de galeria. Embrapa-CPAC, Planaltina, p.164.
- [25] Silva, R. R., Fortuna-Perez, A. P.; Tozzi, A. M. G. A. (2007). Novas ocorrências de Leguminosae para o Mato Grosso do Sul, Brasil. *Rodriguésia*. v. 58, p. 249-254.
- [26] Simon, M.F.; Grether, R.; Queiroz, L.P.; Särkinen, T.E., Dutra, V.F. & Hughes, C.E. (2011). The evolutionary history of *Mimosa* (Leguminosae): toward a phylogeny of the sensitive plants. *American Journal of Botany* 98: 1201-1221.
- [27] Sprent, J.I., Ardley, J.K., James, E.K. (2013). From North to South: A latitudinal look at legume nodulation processes. *S. Afr. J. Bot.* 89: 31–41.
- [28] Strassburg, B. B. N.; Brooks, T.; Feltran-Barbieri, R.; Iribarrem, A.; Crouzeilles, R.; Loyola, R.; Latawiec, A. E.; Oliveira-Filho, F. J. B.; Scaramuzza, C. A. M.; Scarano, F. R.; Soares-Filho, B.; Balmford, A. (2017). Moment of truth for the Cerrado hotspot. *Nature Ecology & Evolution*. v. 1, n. 0099, p. 1-3.
- [29] Tropicos. (2018). Tropicos.org. Jardim Botânico de Missouri. 10 de fevereiro de 2018 disponible in <<http://www.tropicos.org>>
- [30] Yahara, T.; et al. (2013). Global legume diversity assessment: Concepts, key indicators, and strategies. *Taxon*. v. 62, p. 249–266. Perfect, T. J., & Schwartz, B. L. (Eds.) (2002). *Applied metacognition* Retrieved from <http://www.questia.com/read/107598848>

Organizational Learning - The main factors that facilitate learning and the barriers from the perspective of managers

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Abstract—This study seeks to identify and analyze the aspects that favor and those that hamper learning in the organization according to the perception of managers Coamo Cooperativa Agroindustrial unit of Paranaguá PR, analyzing how the learning process in an organization can be favored and what barriers can be found. Having as justification that through the understanding of the presented problem, it is possible to constitute a diagnosis of the organizational practices. With the necessary practices in the process of change and development of the organization bringing the proposal of the learning in order to improve the capacity of action of the individuals involved and of the organization as one all. It begins by contextualizing the objective of this study, presenting a review of the referential with the survey of the most relevant and pertinent aspects to the theme. Following, a description of the methodology adopted in this research carried out in the exploratory qualitative research modality, which contemplates a case study. The research was carried out at the Coamo Agroindustrial Cooperativa Unidade de Paranaguá in Paraná, with questionnaires applied to the members of the company. Because it is a study of a specific case, the research delimits the analysis in the experience of a working group within an organization, however it was possible to have the vision about learning, as it happens, which can facilitate or impair learning in an organization.

Keywords—Factors for learning, learning process, organizational learning, types of learning.

I. INTRODUCTION

The central idea that led to the execution of this work was the interest in the growing process of learning regarding the organization, the ways in which they can lead to a better use of collective and individual knowledge of the team, with the purpose of generating competitive

advantages for the organization. Thus, the desire for analysis of the learning and knowledge generation aspects was stimulated.

One of the purposes of this work was to analyze organizational learning, understanding how organizational learning happens, raising the main organizational learning practices and identifying obstacles to organizational learning. From the understanding of the learning process within the organization, through data surveys one can then theorize about it.

The performance of organizations is directly aimed at those who make it up; its employees, then the individual and knowledge are seen as strategic means for the creation and dissemination of new values and resources that corroborate in the improvement of processes. In face of daily changes the internal and external environment in organizations, in this context, identifying the observation that intangible assets are becoming key components in organizations. Thus making it essential to adapt to the environment in order to remain competitive, promoting in some way learning through acquisition of information or knowledge that its members consider useful for the quality of the organizational performance. It is the exposed of which the main factors that somehow facilitate the organizational learning and factors or barriers for the learning in the managers view.

The theme of learning within organizations has emerged with great relevance both in the question of theoretical and in managerial practice. It consists of the capacity that organizations develop in a way that acquires knowledge from experiences, which in turn will bring about changes in their functioning based on such knowledge, thus increasing its capacity to generate and apprehend knowledge, a factor that has been the main competitive differential of organizations in the current context.

Vasconcelos and Mascarenhas (2007) in this same line of thought indicate that learning presupposes behavior change resulting from a continuous and growing acquisition of knowledge about oneself and about the environment. This given, the development of learning is seen as the acquisition of knowledge that causes that in addition to the individual who is being shaped or who has a modification of the vision of what he knows, begins to observe in another way the environment in which it is inserted, acting in a different way than it was before learning.

In the question of the competitive differential, Prahalad and Hamel (1995) corroborate in this sense that a company becomes more competitive the moment they turn to the attention for essential competences. It is represented as an expanding set of knowledge, the sum of the learning from all skill sets on a personal level as well as from the organizational unit. In short, the learning process can be facilitated when the environment is conducive to development in the organization, but can also be impaired when there are barriers or barriers to learning.

In this sense, the analysis of learning processes in organizational contexts has been an important way to understand the dynamics of organizations. The changes resulting from social systems have repercussions on the configuration of new organizational formats and the adoption of managerial models. These managerial models, in turn, require employees and managers willing to learn. Since it is, the ability to learn that allows the development of skills that enable the organization to identify process and retain new information to increase knowledge and improve the process of making competitive capacity (Bastos, Gondim, & Loiola, 2004).

Durand (apud Brandão, 1999) suggests a concept of competency based on three dimensions - knowledge, skills and attitudes - associating cognitive, technical, social and affective aspects related to work. Knowledge corresponds to a series of information assimilated and structured by the individual, which allows him to "understand the world". Skill corresponds to the ability to apply and make use of the knowledge gained in pursuit of a definite purpose. The attitude refers to the social and affective aspects related to the work, which explain the behavior normally experienced by the human being in his work environment. The three dimensions proposed, according to Durand (apud Brandão, 1999) occur simultaneously, since an individual does not perform a task that requires the application of a certain skill, without first knowing the fundamentals of it. It is necessary for organizations to incorporate this learning cycle: Where they first acquire skills, they come to know their reality and then the necessary knowledge is generated, in this

way the attitudes will be: Inhibited, stimulated or developed in people.

In Argyris and Shon (1976) propose the existence of two learning models, called single loop and double loop, based on the theory that all human action was based on theories of action. According to the authors, single-loop or simple cycle learning is an instrumental learning involving the detection and resolution of problems according to the rules established by the organization (its theory of action). Individuals claim to follow one theory, and in fact, unconsciously practice another. In other words, a resistance arises to critically observe situations, which causes inhibition to question existing rules and procedures and the development of new solutions, to let the values of a theory of action remain unchanged, that is, it detects and corrects the error, but does not change the current model.

Dual-cycle learning would involve overcoming this defensive posture, questioning what is established in the organization, and, through learning the situation, promoting the changes necessary to achieve solutions. This is to question what is learned by doing a revision of principles, in turn, occurs when, in addition to the detection and correction of error, changes in norms, policies and objectives occur. That is, when, in addition to correction of error, learning also covers the development of avoid it, it gives the learning double-loop or double-loop with reference to two feedback loops. (ARGYRIS; SCHÖN, 1996).

Contextualizing Senge (1990) in his studies contributes by referring to the simple circuit as generative learning that emphasizes continuous experimentation and feedback, which involves the analysis of how organizations define and solve problems using the disciplines of personal domain, mental models, shared vision, group learning, and systemic thinking. In contrast, dual circuit is considered as adaptive learning by focusing on problem solving in the present, without properly examining current learning behaviors.

Other authors such as DiBella and Nevis (1999) also present the organizational learning cycle that portrays a series of three processes: generation or acquisition of knowledge, dissemination of knowledge and use of knowledge. The occurrence of learning requires the realization of all processes of the cycle, and unless knowledge is disseminated, it will remain as private property and not as property of the organization.

Thus, the Ten Facilitating Factors are conceptualized, they reflect the influence they exert on each segment of the organizational learning cycle: Imperative Research: People seek information about conditions and procedures outside their own unit; seek to know the external environment. Performance Diffusion:

Generalized perception that there is a difference between actual and desired performance. Concern with Measurement: Considerable efforts are spent on defining and measuring basic factors. The discussion of measurement criteria is considered a learning activity. Organizational Curiosity: The curiosity about conditions and practices and the interest for creative ideas and new technologies, propitiate the experimentation. Opening Climate: Members of the organization communicate openly; problems, mistakes and lessons are freely shared, never hidden. Continuing Education: There is a constant commitment of the organization to provide a high quality resource for learning. Operational Variety: Members value the variety of methods, procedures, and competencies; appreciate diversity. Multiple Defenders: Employees at all organizational levels are encouraged to develop new ideas and working methods. Existence of multiple advocates or leaders. Leadership Involvement: Leadership is involved, personally and actively, in learning initiatives and ensures the maintenance of an environment conducive to its occurrence. Systemic perspective: Recognition of the interdependence of the various organizational units and groups; awareness of the need to pass time between actions and obtain their results.

In the model of learning proposed by Senge (1990) shows that the desire to learn is creative and productive, however, people will only show better results in their activities and in the processes of the organization when they have knowledge of their contribution in the process of organizational change. Senge proposes the development of five fundamental disciplines: personal domain, mental models, shared vision, team learning and systemic thinking. It is of fundamental importance that the five disciplines work together. (Senge, 1990, p. 21).

According to studies of several authors in the area of organizational learning, there are means that favor and means that make learning difficult in organizations, synthesized among the contributions in the facilitator aspect. The contributions of the authors DiBella and Nevis (1999) emphasize that the facilitators of organizational learning have normative characteristics, because the stronger the presence of them in an organizational unit, the greater the probability for learning to occur. The facilitating factors for learning are the political practices and conditions that catalyze the occurrence of learning. That is, the sources of information, the sharing of visions and experiences, the acceptance of surprises and difficulties, the revision of preconceptions, the feedback new ideas and opinions, the learning environment and psychological safety, providing the reasons and incentives that promote this learning in the organization. In this same vision Garvin, 2000, defines the facilitating factors of learning as: Sources of

information, sharing visions and knowledge, acceptance of surprises, review of prejudices, timely feedback, new ideas and opinions, learning environment, psychological security.

Tied to facilitators or the process, are the basic parameters to describe or characterize as organizational learning as the authors DiBella and Nevis (1999) about how learning occurs through knowledge sources where development occurs internally or externally. It is developed by the content focus in which process the emphasis given to the knowledge about what it represents, the products or the services compared to the emphasis given to the knowledge about these products or services are developed and made available to the market. The reserve of knowledge, i.e. knowledge that is of particular domain compared to knowledge that is in the public domain. The mode of dissemination, as knowledge is shared, whether through formal or rigid methods compared to the knowledge that is shared informally in casual contacts or which is the result of behavioral modeling learning scope. This model defines what the preference for knowledge related to the improvement of capabilities, existing products or services compared to the preference for knowledge related to the development of new capabilities, products or services. Focus value chain in this case the emphasis given to investments in learning related to engineering or production activities (functions of type design and execute) versus sales or service (depending on the type markets and delivered). Finally the focus on learning: the development of knowledge pertaining to individual performance compared to the development of knowledge pertaining to group performance.

At all stages of learning there are several deficiencies that can occur and can disrupt the process, reducing its efficiency. Morgan (1996) reports that the organizational learning process often comes up against bureaucratic approaches in organizations that impose fragmented structures of thought on employees, not encouraging people to think for themselves. Through established organizational goals, goals, structures and roles, the company creates defined patterns of attention and responsibility by fragmenting interest in a knowledge of what the organization is doing.

Some of these barriers are created by stress, pressure and high expectations, causing attention and focus to be reduced, generating learning problems where, according to Garvin's studies, 2000, these barriers are the biased information that are caused by blind spots, bad judgments that restrict the amount of information processed, leading to incomplete and incorrect assumptions. In addition, the fault interpretation that is very common for the complexity of the interpretative

judgment that can be polluted by particularities of the individuals, generating distorted information; the inaction that can be translated by the lack of capacity to act in relation to the new information captured. The changes must be clear and understood, understanding the need for these new actions;

Through the different theoretical contributions, it is observed that, in learning organizations, people are not trained to simply perform their functions, but rather to perform a work of excellence that adds value to feeling satisfaction.

II. MATERIALS AND METHODS

This study is a case study of a quantitative and descriptive exploratory nature. For GIL (1999) the case study is characterized as a research of high degree of depth and of exhaustion that allows the deepening of one or few objects in a detailed way.

According to Mattar (2007), the descriptive modality is used with the objective of: "Describe the characteristics of groups, estimate the proportion of elements in a specific population that have certain characteristics of a given problem and describe behavior and discover or verify the existence of relation between variables".

The methodology of this exploratory study has a quantitative approach through the application of research, in which this approach was chosen in the quest for the accuracy of the results obtained, thus providing a greater security in the analysis to be performed.

In the identification of the data collection were used primary sources, where as a technique of data collection was used the questionnaire, according to Cervo, Bervian and Silva (2006), makes it possible to accurately measure what is desired. According to Marconi and Lakatos (2007), the questionnaire is an instrument of data collection, consisting of an orderly sequence of questions, for better data collection should be answered in writing and without the presence of the interviewers. With the option of non-interviewees placing their identification so that the questionnaire has an effect of proximity to reality, will allow to cover a larger number of interviews.

The secondary data were extracted from the existing literature on the subject and incorporated into the field research. It contacts an already existing questionnaire composed of closed questions, extracted from the studies of Alcântara (2014).

In the analysis of the collected data the likert scale was used with answers of 1 to 5, where 1 - I totally agree; 2 - I agree; 3 - Neutral; 4 - I disagree; 5 - I totally disagree. According to Malhotra (2001), we use a measurement scale with five categories of responses, ranging from "Strongly Disagree" to "Strongly Agree",

which requires respondents to indicate a degree of agreement or disagreement with each of the variables related to stimulus objects.

The questions were grouped in facilitating factors, being: Imperative Research and sources of information. Performance gap and sources of information. Concern with measurement and feedback. Organizational curiosity and acceptance of surprises. Opening climate and learning environment. Continuing education and learning environment. Operational variety and sharing visions and knowledge. Multiple advocates and psychological security. Involvement of leaderships, revisiting prejudices, new ideas, and opinions. Systemic perspective and sharing of visions and knowledge.

After tabulation and calculations via Excel program, graphs were produced to illustrate the samples demonstrating the degrees of agreement by facilitator factors and stages of the knowledge cycle. In sequence, the graphs were analyzed according to the Likert Scale Values Interpretation table.

2.1. DATA COLLECTION

The research was carried out by means of a virtual questionnaire, where a link of a web form (Google forms) was sent to the leaders of the study organization, which was answered between January and February 2019.

The research universe comprised 16 responses obtained by the interviewees. This questionnaire was the guideline of the research where it was elaborated in order to understand the main factors that somehow facilitate organizational learning and factors or barriers to learning in the managers' view.

III. INCOME STATEMENT

At the request of the interviewees their names were preserved. The profile of the interviewees in which the questionnaire was applied, who in turn are managers, among which are department heads, operational managers, operational assistants, maintenance and security officers. As for the gender account has 15 males and 01 of the sex female, about 80% work in the organization for more than ten years, being the interviewee with a shorter time of two years, in relation to their training 90% have higher education and relevant technical knowledge in their respective areas.

3.1 FIGURES AND TABLES*Table.1: Imperative research and sources of information*

Description	Standard deviation
1. Do you care to seek information that contributes to the improvement of your processes based on the best practices adopted by your competitors / partners?	4,438
2. Do you seek information that contributes to the understanding of your environment with your peers (meetings, meetings, events)?	4,381
3. Do you use the information of the results obtained by your organization comparative to other organizations and their positioning towards suppliers, customers?	3,701

Based on the obtained answers, the standard deviation of this factor had as its highest value the question 01 of 4,438 where they are represented by 43.8% of the respondents. The respondents said they agree and 56.3% agree fully, and the lowest value is question 03 with 3,701, represented by 25% of the respondents who fully agree, 56.3% agree and 18.8% are neutral.

Table. 2: Performance gap and sources of information

Description	Standard deviation
4. Do you seek to achieve the goals specified by the organization in relation to your processes?	4,438
5. Do you care to question your work regardless of the goals you set?	3,962

In the item Performance gap and information sources, the highest standard deviation was 4,438 where 56.3% of respondents fully agree and 43.8% agree and represent 3,962 of standard deviation, 50% of respondents fully agree, 43, 8% agree and 6.3% are neutral.

Table.3:Preoccupation with measurement and feedback

Description	Standard deviation
6. Are there questions about how things are done?	4,086
7. Do you evaluate the results obtained from a new knowledge added to your processes?	4,604

Concerning measurement and feedback, these are important factors in the generation and maintenance of a learning process. The variable of question 07 presented the

highest value of standard deviation 4,604 in which 62.5% agreed and 37.5% agreed fully, already with 37.5% agreeing fully, 56.3% agreeing and 6.3 neutral ones the standard deviation value of 4.086.

Table.4: Organizational curiosity and acceptance of surprises

Description	Standard deviation
8. Do you allow yourself to try new ways of acting / working?	4,381
9. Do you use contingencies to create new work routines?	4,438

In the factor Organizational curiosity and acceptance of surprises with the value of 4,438 represents the highest standard deviation of this item in which 56.3% fully agree and another 43.8% already agree with the lowest value 4.381 represented by 50% of respondents who fully agree and another 50% who agree.

Table 5: Organizational curiosity and acceptance of surprises

Description	Standard deviation
10. You have a habit of sharing best practices with other coordinators of other organizations	2,774
11. Coordinators from other organizations are in the habit of sharing their best practices with you.	2,588

In this item, the standard deviation with the highest value presented with 2,774 was in question 10, where 37.5% fully agree, 37.5 agree 18.8% if they say neutral and another 6.3 disagree. Representing 2,588 of standard deviation in question 11, 25% fully agree, 31.3% agree on 37.5 neutral and 6.3 are discordant.

Table 6: Continuing education and learning environment

Description	Standard deviation
12. You seek continuous improvement to improve your processes.	4,381
13. You seek unstructured improvement on an ongoing basis to improve your processes.	2,949
14. You are free to pursue this improvement in your work schedule.	3,834

In the continuing education factor and learning environment were divided into 50% those who fully agree and 50% who agree, representing the highest value of

standard deviation in the answers in question 12, with the standard deviation value 2,949, 18.8% fully agree, 50% agree, 18.8% neutral and 12.5% disagree..

Table 7: Operational variety and sharing visions and knowledge

Description	Standard deviation
15. You have the flexibility to propose alternative solutions to the problems you face.	4,868
16. Other coordinators have the flexibility to propose alternative solutions to the problems they face.	4,147
17 There is this flexibility of proposing alternative solutions between sectors / departments de soluções alternativas entre setores/departamentos	4,658

Regarding the operational variety and sharing of views and knowledge, the highest value of standard deviation of the answers obtained was 4,868 in question 15, where 31.3% fully agree and 68.8% agree on question 16, the standard deviation was 4,147 had as answers 25% fully agree, 62.5% agree and 12.5% are neutral.

Table 8: Multiple Defenders and Psychological Safety

Description	Standard deviation
18. There are favorable conditions for the implementation of new processes based on suggestions.	5,215

The Multiple Defensor and Psychological Safety factor had the standard deviation in the responses of 5,215 where 25% fully agree and 75% agree.

Table 9: Involving leaders and reviewing prejudices, new ideas and opinions

Description	Standard deviation
19. The leaders of your organization institution stimulate the learning environment.	4,438

Regarding the involvement of leaders and revising precepts and new ideas and opinions with 4,438 in the standard deviation, 43.8% fully agree and 56.3% agree.

Table 10: Systemic Perspective and Sharing of Visions and Knowledge

Description	Standard deviation
20. You are able to identify an external factor as an opportunity or threat to your Institution.	4,604
21. You are able to identify an internal factor as an opportunity or threat to your Institution.	4,086

In the Systemic Perspective and sharing of views and knowledge the standard deviation of the answers obtained representing 4,604 with 37.5% who fully agree and 62.5% agree, and 4,086 of standard deviation 56.3% agree, 37.5% fully agree and 6.3% neutral.

IV. DISCUSSION

Observing the results demonstrated in the previous session in which they are presented through the factors influencing or hindering learning. In the item of tab.1 it was tried to evaluate the factor Investigation imperative and sources of information in which given its importance, according to Garvin (2000) the learning can only occur in organizations that have a great source of information. According to Costa (2003), information is conceived as raw material to generate knowledge. It can be observed that there is interest in the search for information aiming to contribute to the improvement of learning, but it is usual to compare the results with the external environment.

As described in tab.2 the learning potential is commensurate with the openness offered by the organization so that stakeholders can identify and discuss the effects of performance gaps by questioning their independent performance of goals demonstrating engagement with results. Performance Perception represents collective awareness of the differences between actual, concrete and objective performance and desired or expected performance. As represented here is the involvement by the majority interviewed in the concern with the performance gap in relation to the concern in questioning what is accomplished with a personal charge for the results to be achieved.

In tab.3 the item concern about measurement and feedback, it is believed that through joint participation, the practice of dialogue works as an incentive to the development of new skills, contributing to the decision-making and implementation of more effective actions. The concern with this measurement indicates a certain degree of commitment to learning, the greater this concern, the more adequate will be learning in the organization (DIBELLA, NEVIS, 1999).

Organizations whose individuals are predisposed to accept unexpected events and surprises, occurrences out of sight during the day, allow the creation of an environment for organizational learning, Gavin (2000). According to the results shown in tab. 4, the organizational structure is very dynamic and the flexibility of the individuals that make up the organization is fundamental. It is important that they are adaptable to possible changes and rapid transformations by analyzing the answers it is possible to observe that the interviewees deal with unforeseen changes into new forms of action.

In relation to the opening Climate and learning environment this factor is related according to Dibella; Nevis, (1999) with the freedom of communication that individuals possess among other sectors, within their own sector and among other organizations. Through the result described in tab.5 it is possible to understand that the respondents perceive the existence of this factor, but disagree with the existence of this factor in the relations with distinct organizations.

According to Garvin (2000), "learning organizations are organizations that are capable of creating, acquiring and transferring knowledge and modifying their behaviors to reflect these new insights and insights" DiBella and Nevis (1999), organizations need to create an enabling environment education continues for both the subjects of immediate and technical use as well as for the disciplines coming from individual initiative. One can see the answers obtained in items 12 and 14 of tab.6 that the organization provides an environment that facilitates learning through continuing education and the employees have stimulated the search for improvement.

In the item Operating variety and share views and knowledge in the tab.7, it is exposed that there is possibility and effective participation of the groups involved in the decisions and are stimulated the participation and in proposing alternatives to the problems. Organizations that support diversity and variations in the strategies, policies, processes and skills of their individuals provide a more efficient learning environment, Garvin (2000).

With regard to the multiple advocacy factor and psychological security, this factor tries to evaluate the effect of individuals able to defend new ideas and processes throughout the organization, as explained by DiBella and Nevis (1999). Through the result obtained according to tab.8 it is possible to state that everyone is encouraged to develop new ideas and working methods.

It is also possible to observe through the results of tab. 9 that the leaderships are actively involved in the learning initiatives and thus ensuring an environment conducive to their occurrence. If the organization's goal is

to foster learning, it will be up to leaders, in addition to involvement, to ensure that the learning environment is maintained (DIBELLA; NEVIS, 1999);

Finally, through the results of tab.10 it is possible to describe that respondents aim to build the vision of business owner by committing themselves to the results they are delivering to the organization having the ability to identify their own organizational boundaries before looking for external motives and reasons. It concerns the ability to observe short-term results and to understand how they can affect the organization in the long term or determine the outcome of other parts of the organization (DIBELLA and NEVIS, 1999).

V. FINAL CONSIDERATIONS

The objective of this research was to analyze which are the main factors that facilitate in some way the organizational learning and factors or barriers to learning in the view of the managers. In order to reach this goal, a review of the theory about organizational learning was carried out, factors that bring benefits and factors that make learning difficult. It was also sought to identify the main components of knowledge practices in which factors related to communication were raised organizational, knowledge strategies, stimulus to learning, organizational climate and feedback, capacity measurement and access to information.

With the results obtained from the research, it is possible to raise the existence of facilitating factors and impediments of organizational learning in the theoretical context. Compared to practice, the members of the organization interviewed who in turn are managers, and most male who act at a considerable time in the organization. The great majority has been working for more than ten years in the organization, 90% of them have higher education and relevant technical knowledge in their respective areas, and can be considered as learning enablers and disseminators of knowledge. It is possible to affirm that the learning in this specific study is influenced by the organizational set, that is, the organizational culture stimulates the learning, to what is impregnated, what is exposed in those that compose the organization is responsible for the stimulus to the learning. The set of personal and organizational aspects that arise from the work environment available, want to learn and teach, the relationship between the agents involved, access to information and openness in the sharing of opinions and knowledge translate the openness to learning. The counterpart can be drawn from the bibliography already produced that inhibiting factors such as fear of exposure, culture of obedience, excess of norms and procedures, intolerance to error, individualism and

pressures are responsible for the regression in the learning.

To perform the verification of the data, it was found that the results indicate that respondents seek for information that contributed to the improvement of processes. However, it is not common to use the information from the results obtained by your comparative organization the other organizations, as well as for the involvement of respondents in concern with the performance lag where one has the concern in question what is accomplished and the possible outcomes to be achieved. It also determines the degree of commitment to learning, where the higher this concern, more appropriate learning in the Organization, can be stated also that in this organization respondents allow themselves to experience in new forms of action in which use of consequential to create or improve routines. The organization's ability to innovate and learn is linked to the styles and values adopted by its members, how each individual retains information is based on their own experiences, observations, and values (ARGYRIS & SCHON, 1996).

Regarding the Climate of openness and learning environment, this factor is explicit in the organization that contributes with sharing of visions and knowledge as well as suggestions that will collaborate through improvements, where it is also possible to affirm that it provides an environment that facilitates learning through education and the employees have a stimulus in the search for improvement.

The contribution of this study is to confront theory and practice in the confirmation of organizational learning, its benefits when applied correctly adding value to the company by developing personal skills that imply learning in the organization. The learning organization provides conditions for individuals to learn and retain knowledge, promoting organizational change so that it can act in the environment in which it operates effectively.

In this way, it allows to say that the proposed objectives were reached in the analysis of the organizational learning, being possible to understand how organizational learning happens, the main practices of organizational learning and the identification of the obstacles to organizational learning through the literature, responding to the general objective. The main factors that somehow facilitate organizational learning and factors or barriers to learning in the view of managers with the survey of the data through questionnaire with closed questions applied with the members of the organization in turn managers were raised and identified here.

REFERENCES

- [1] ALCANTARA, M.M. F. Fatores facilitadores da aprendizagem organizacional para a criação de significado em instituições de ensino superior privada de Curitiba e região metropolitana. Dissertação. (Mestrado em Gestão e Tecnologia da Informação do Setor de Ciências Sociais Aplicadas) da Universidade Federal do Paraná. 2014.
- [2] ARGYRIS, C.; SCHÖN, D. A. *Organizational learning II: theory, method, and practice*. New York: Addison-Wesley, 1996.
- [3] ARGYRIS, C.; SCHÖN, D. A. Organizational Learning: a theory of action perspective. p. 345- 348, 1997.
- [4] BASTOS, A. V. B., GONDIM, S. M. G., & LOIOLA, E. (2004). Aprendizagem organizacional versus organizações que aprendem: características e desafios que cercam essas duas abordagens de pesquisa. *R.Adm.*, São Paulo, v. 39, n. 3, p. 220- 230, jul./ago./set.
- [5] BITENCOURT, C.C. A. Gestão de Competências Gerenciais: A contribuição da aprendizagem organizacional. 2001 Tese (Doutorado em Administração) – Programa Pós-Graduação em Administração, Universidade Federal do Rio Grande do Sul, Porto Alegre, 2001.
- [6] BRANDÃO, Hugo P. (1999) Gestão baseada nas competências: um estudo sobre competências profissionais na indústria bancária. Dissertação (Mestrado) – Brasília - Universidade de Brasília, 158 p.
- [7] CALDEIRA, A.; GODOY, A. S. Barreiras e incentivos à aprendizagem. *São Paulo - SP, Brasil, v. 18, n. 4, p. 513-530, out./dez. 2011. REGE*.
- [8] CERVO, BERVIAN e SILVA, Metodologia científica 6ª edição. São Paulo: Editora Pearson Education do Brasil, 2006.
- [9] COSTA, Marília Maria Roslindo Damiani. Procedimentos para aplicação de mapas semânticos como estratégia para criação do conhecimento organizacional. 2003. 195 f. Tese (Doutorado em Engenharia de Produção), Universidade Federal de Santa Catarina, 2003.
- [10] DIBELLA, Antony J.; NEVIS, Edwin C. Como as organizações aprendem. São Paulo: Educator, 1999.
- [11] FERRAZ, A. P. C. M.; BELHOT, R. V. Taxonomia de Bloom: revisão teórica e apresentação das adequações do instrumento para definição de objetivos instrucionais. *Gestão&Produção, São Carlos, v. 17, n. 2, p. 421-431, 2010*.
- [12] GARVIN, David A. Learning in action: a guide to putting the learning organization to work. Harvard Business School Press: Boston, Massachusetts, 2000.
- [13] GARVIN, David A. Aprendizagem em Ação: um guia para transformar sua empresa em uma learning organization. Rio de Janeiro: Qualitymark, 2002.
- [14] GIL, Antonio Carlos. Métodos e técnicas de pesquisa social. 5 ed. São Paulo: Atlas, 1999.
- [15] LAKATOS, MARCONI. Técnicas de Pesquisa. 6 ed. São Paulo: Atlas, 2007.
- [16] MALHOTRA, N. Pesquisa de marketing: uma orientação aplicada. 3. ed. Porto Alegre: Bookman, 2001.
- [17] MATTAR, F.N. Pesquisa de Marketing. 3. ed. São Paulo: Atlas, 2007.
- [18] MOREIRA, M. A.. Aprendizagem significativa. Brasília: Editora Universidade de Brasília, 1999.

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- [19] MORGAN, Gareth. *Imagens da organização*. São Paulo: Atlas, 1996.
- [20] NEVES, José Luis. *Pesquisa Qualitativa: Características, usos e possibilidades*. Cadernos de pesquisas em Administração. São Paulo, V.1 n3,2º Sem, 1996.
- [21] PRAHALAD, C.K, e G. HAMEL. *Competindo pelo futuro*. Rio de Janeiro: Campus, 1995.
- [22] RIGANO, D.; EDWARDS, J. Incorporating Reflection into Work practice. *Management Learning*, v.29, n. 4, p 431-446, 1998.
- [23] SENGE, Peter M. *A quinta disciplina*. São Paulo: Editora Best Seller, 1990.
- [24] SENGE, P. *et al.* *A quinta disciplina*. Caderno de campo. Trad. de Antônio Romero M. da Silva. Rio de Janeiro: Qualitymark, 1997.
- [25] SENGE, P.M. *A quinta disciplina: arte e prática da organização de aprendizagem: uma nova e revolucionária concepção de liderança e gerenciamento empresarial*. 23 ed. São Paulo: Best Seller, 2008.
- [26] SHAW, R. B; PERKINS, D.N. *Ensinar às organizações a aprender: O poder dos fracassos produtivos*. In: NADLER, David. *Arquitetura Organizacional: A chave para a mudança empresarial*. Rio de Janeiro: Campus, 1993.
- [27] VASCONCELOS, Isabella F.G de e MASCARENHAS, André O. *Organizações em aprendizagem*. Coleção debates em Administrações. São Paulo: Thomson Learning, 2007.

PEC-G: An Analysis of the Student Program-Graduate Agreement at the state university of Londrina - Brazil - in the Perspective of Students

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Abstract— *The Student-Graduation Agreement Program (PEC-G) is one of the instruments of educational cooperation that the Brazilian government offers to other developing countries in Asia, Africa and Latin America. The Ministry of Foreign Affairs (MRE) and the Ministry of Education (MEC) are mainly responsible for the overall coordination of the Program, while the Higher Education Institutions (HEIs) are responsible for the reception and training of students. In this sense, this article has as general objective to understand the Program of Students-Agreement of Graduation (PEC-G) at the State University of Londrina (UEL) from the perspective of the main social actors involved: the foreign students. Due to lack of space in this article, the position of the managers of the program in the UEL and in the MEC was left out. As for the research methodology, the Case Study and the Bibliographical Study were used, with a qualitative approach, the instruments of data collection were questionnaires and interviews. Among the conclusions of the study, it is possible to emphasize the students' deficiency in learning the Portuguese language before arriving in Brazil; the difficulty of living and the lack of resources to support themselves in Brazil; the need for investments by UEL in socialization actions of new students who enter each year at the University.*

Keywords— *Public policies; Social actors; Students.*

I. INTRODUCTION

The Undergraduate Student-Covenant Program (PEC-G) is a vacancy in Higher Education Institutions (HES) for foreign students whose objective is to attend undergraduate courses in order to become professionally qualified. The PEC-G represents one of the oldest international cooperation's in Brazil, which, according to Duarte (2016), in 1964, received its current denomination through the report of the Ministry of Foreign Relations - MRE, directing its own actions to the IES, without the participation of the Ministry of Education - MEC. In 1974, the MEC and the MRE signed the second protocol seeking its greater efficiency.

Currently, the Program is governed by Decree 7.948, dated March 12, 2013, repealing Decree 55.613, of January 20, 1965, whose purpose was to regulate and adapt the PEC-G. According to Duarte (2016), this was the first significant modification of the Program since its inception, being extremely important for monitoring Brazil's foreign relations.

The objective of the program is to strengthen

relations between governments, which need to pay for maintenance, accommodation, transport and food for students who come to Brazil to study. The benefits provided to Brazil in terms of foreign policy are to contribute to the development of the countries agreed by the qualification of students, and for the institutions the benefit is the opportunity for cultural and social exchange between foreign students and Brazilians.

It is the responsibility of the HES to host and train these students, thus requiring a continuous evaluation of the evolution of the Program and the valuation of PEC-G students, paying them in the academic environment and in research, teaching and research activities. extension.

In order for the students to achieve a good income, a policy built with the social participation of the actors involved is necessary.

For Höfling (2001), it is fundamental, in the implementation of the Public Policy, an evaluation in its implementation, and not only in the evaluation of the results created by it. With regard to Educational Policies,

which contextualize the object of study of this work, the G-PEC, it is worth observing what determines the legislation, the determination of education as a right of all, provided for in articles 6 and 205 of the Constitution of the Federative Republic of Brazil of 1988.

Souza (2006) states that Public Policies can be understood as a set of governmental decisions, plans, goals and actions, together with the state, federal and municipal spheres, aimed at solving problems or public interests, whose actions must reach the well-being of society.

For the foregoing, this article aims to answer the following question: what evaluation do foreign students conceive of the Undergraduate Students-Agreement Program (PEC-G) held at the State University of Londrina?

The performance of the university is of fundamental importance in the context of exchange and cooperation, and the strengthening of the development processes of the agreed countries, as well as the organization of the necessary procedures to offer experiences and experiences of reception and educational quality to the students. In this context, from the studies and results presented in the master's thesis "The undergraduate students-agreement program (PEC-G in the state university of Londrina: an evaluation from the perspective of the social actors involved", of the Professional Master's Program in Public Policies, from the University of the Vale do Itajaí, we made a cut focusing on the evaluations expressed by the scholarship students around the Program of Students-Graduation Agreement - PEC-G at the State University of Londrina.

The general objective of this study is to: Understand the evaluation of foreign students about the Undergraduate Students-Agreement Program (PEC-G) held at the State University of Londrina.

Thus, the PEC-G, the object of analysis of this study, is one of the instruments of educational cooperation that the Brazilian government offers to other developing countries, seeking the collectivization of access to education and more opportunities for qualification of human resources to young people from a developing country (MRE, 2016)

For the preparation of this work, it was sought to understand, through theoretical reference, the Public, Social and Educational Policies, considering the approaches and concepts necessary for an understanding of the Undergraduate Students-Agreement Program, through federal legislation, in addition to the legislations of the Institution regarding the Program, for the realization of the understanding and functioning of the

Institution in Brazilian HEIs.

Thus, the work delimits a public institution, in this case, the UEL, since the action, in this public body, is already defined with its laws and decrees. In spite of this, it needs internal actions pertinent to the understanding of the PEC-G for an institutional evaluation, providing benefits to the students, to the University, as well as to the country of origin of the students, which maintains cooperative relations with Brazil.

II. METODOLOGY

Through the Case Study of active students at UEL and the coordinators and teachers responsible for the G-PEC, the Ministry of Foreign Affairs (MRE) and the Ministry of Education (MEC) understand the evaluation of the Student Program - Undergraduate Agreement - PEC-G at the State University of Londrina by the scholarship students involved in it, inspect their conditions and proposing actions and mechanisms for improvements and adjustments to Public Policies at UEL.

This is a qualitative approach research, as a research technique, were semi-structured interviews. According to Gil (2008), the research is developed through a fixed list of questions, so that, for the accomplishment of the research, a descriptive study method was adopted, whose data collection was elaborated by documentary, bibliographic research. In it, a survey was elaborated by means of interviews and questionnaire, in which the questions remain invariable for all the interviewees - are open questions in which the respondents have their own way of writing the answers.

For the application of the questionnaire, the following criterion was observed: only questionnaires would be sent to active students, that is, enrolled and studying, totaling 29 (twenty-nine) students, while interviews with coordinators and teachers, as well as MRE managers and MEC, made 3 (three) in total.

III. THEORETICAL FRAMEWORK

3.1 Students-Undergraduate Agreement Program: PEC-G as Cooperation Program

Graduation for the PEC-G student is free, however, the student must pay for his / her housing, transportation and food expenses during the period of stay in Brazil. According to data from the MEC (BRAZIL, MEC, 2015), the selected students will be submitted to the Portuguese Course for Foreigners and the Celpe-Bras Exam in Brazil, that is, standardized tests in Portuguese developed by the Ministry of Education.

Data from the Department of Higher Education of the Ministry of Education and Culture (BRASIL, 2014) regarding the 2014-2015 selection process reveal that the most sought-after courses by foreigners in Brazil, through the PEC-G, are: Medicine, Engineering, Administration and International Relations.

In 2014, the Program has completed 50 years, and it is estimated that during that period, approximately 15 thousand young people attended. In a very effective way, the PEC-G encourages the formation of the student-covenant in the expansion of its educational level, since it selects participants between the ages of 18 and 23 who have financial conditions to stay in the place of exchange, without costs for the country of origin and destination (BRASIL, MEC, 2015).

The G-PEC includes developing countries, that is to say, economically less favored ones. For this reason, it is necessary to consider that the students, for the most part, come from families with little financial structure, but declare conditions of staying in Brazil - because this is one of the requirements of the protocol, although they do not always have these conditions (BIZON, 2013). According to Manual of the Program of Student-Graduation Agreement (PEC-G), year 2000, the student should have exclusive dedication. One of the rules prevents the members from carrying out any type of paid work, and because they receive few resources from their families, the student therefore seeks financial resources through an internship.

At present, there are 72 Higher Education Institutions (IES), which are offered to the PEC-G, offering all those approved, free admission and without a competition or entrance examination to students from 58 countries. At present, there are 25 nations in Africa, 25 in Latin America and the Caribbean and 8 in Asia. In 2015, the courses with the largest number of vacancies offered by the universities were: Letters, Social Communication, Administration, Biological Sciences and Pedagogy (DCE, 2016).

Decree 7.948, signed by the President of the Republic, Dilma Rousseff and the Ministers Antônio de Aguiar Patriota and Aloizio Mercadante, mandates the Ministry of Foreign Affairs to coordinate procedures for the implementation of the G-PEC with foreign governments through the diplomatic missions and Brazilian consular offices. In addition, it is the responsibility of the Ministry of Education to coordinate the procedures related to the admission of the HEI to the G-PEC, offer of vacancies, selection and registration of candidates and monitoring of the Program.

By 2018, the Program has been administered in

three parts: the MEC and the MRE are in charge of their overall coordination and the Higher Education Institutions (HEIs) are responsible for the reception and training of the students.

For a better understanding in this respect, according to Maciel (2010, p.6), "we must ask: what is the environment that nourishes and nurtures one's own citizenship and, by correspondence, strengthens the role of the citizen in the control of Public Policies? Obviously this place is the democratic environment. "

It means, therefore, according to the new constitutional order erected by the Federal Constitution of 1988, that, in a democratic environment, there is a great power over the constitution of Rule of Law, whose principles are organized to meet social needs. The guiding principles of the Democratic State of Law, in consonance with Streck and Morais (2000, p.90), are: "constitutionality, democracy, social justice, equality, division of powers, legality, the system of fundamental rights ".

The purpose of social rights is to enable people to have services capable of guaranteeing a minimum quality of life, providing dignified life for the citizen, that is, "represent the way in which society penetrates the State, seeking to: , to control it and to interfere in its administrative structure, in its processes of legitimation and regulation, in its priorities and objectives "(PEREIRA, 2002, p.34 apud MACIEL, 2010, p.4). Else, according to Marshall (1967), allow him to have a civilized life, that is, the state must guarantee the right to life, equality, education, immigration and emigration and association.

However, the process of winning citizens' rights is not homogeneous and linear, establishing that the recognition of citizenship does not always occur from the perspective of universality. In this bias, in the history of citizenship rights in Brazil, "many of the social rights were implemented through a corporatist bias, aiming to meet the demands of the more organized segments of the workers and with greater capacity for political pressure, and therefore did not become universal "(MACIEL, 2010, page 7 apud ARAÚJO, 1998, p.22).

Therefore, in the student-covenant relations of the PEC-G, which presents itself as a differentiated instrument of Public Policies, it is chosen the cooperation with developing countries aiming at the political-ideological commitment with the mobility of students and knowledge coming from outside of the country (BIZON, 2013).

According to the Division of Educational Issues (DCE, 2016), the idea of creating a Government Program

to support students from other countries arose from the increase in the number of foreigners in Brazil in the 1960s and the consequences that this fact brought to the internal regulation of the status of these students in Brazil. There was a need to unify the conditions of student exchange and to ensure that universities offered the same treatment given to Brazilian students. In the last 16 years, 9,218 were selected by the Program.

IV. RESULTS AND DISCUSSIONS

With regard to the PEC-G students in the UEL, 154 students have passed through the Program since its inception, of which 29 (twenty-nine) were active at the State University of Londrina at the time of this research. Thus, questionnaires were sent to 29 (twenty-nine) students, of whom 26 (twenty-six) answered, a membership of 89.66%.

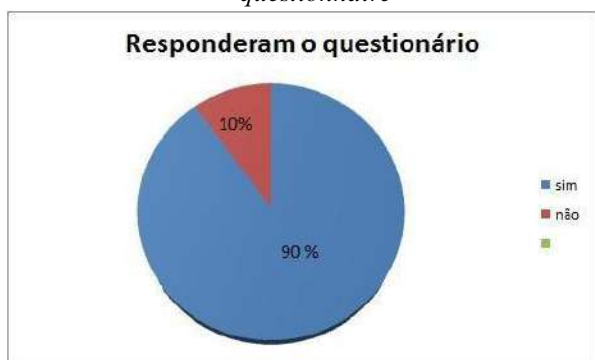
The questions presented to the social actors involved, in the form of interviews and questionnaires, led to the elaboration of this item, in which we intend to analyze the Student Program-Graduation Agreement (PEC-G). This was evaluated by those who benefited and managed the project within the Institution and by those who generally manage the G-PEC in the country through the MRE and the MEC.

4.1 Profile of students

To compose this item, the questions proposed to the students in the questionnaire were presented with the objective of evaluating how the PEC-G held at the State University of Londrina is seen by those who benefit from the Program. In this way, the graphs elaborated with the data provided by the students in the questionnaire are presented below.

Graph 4 presents the proportion (percentage) of students who answered the questionnaire.

Graph 4 – PEC-G students who completed the questionnaire



Fount: survey questionnaire data.

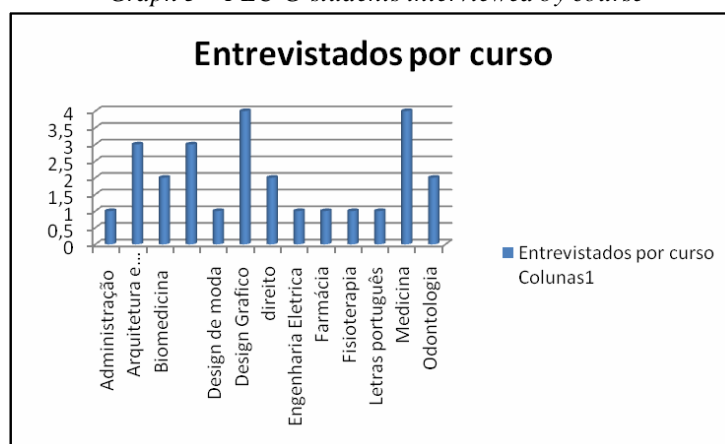
Of the 29 (twenty-nine) students interviewed, 26

(twenty-six) answered the questionnaire, making up 90% (ninety percent), three (3) of which did not respond, ie 10%). The students are willing to participate in the research and contribute to the evaluation of the program.

Of the 26 (twenty-six) participants, 17 (seventeen) are female, while 9 (nine) are male. One can notice a relevant figure in this result: the number of women is greater than that of men, that is, 65% (sixty five percent) belongs to the female sex, while only 35% (thirty five percent) to the male sex, making a total of 100% (one hundred percent) of the students interviewed.

Meanwhile, Chart 5 shows the number of students interviewed per course.

Graph 5 – PEC-G students interviewed by course



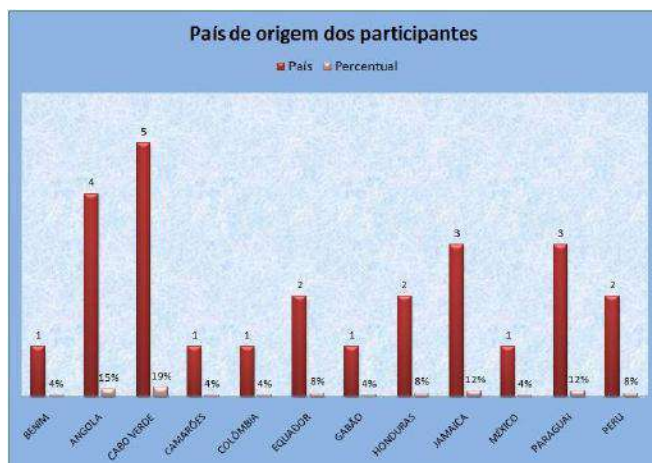
Fount: survey questionnaire data.

It is noteworthy that the largest number of students active in the act of this work was found in the courses of Medicine and Graphic Design. The largest age group in terms of percentages is 21 (twenty one) and 25 (twenty five) years, making up 19% (nineteen percent) of the total.

According to the website of the MEC (2015), the PEC-G selects participants between the ages of 18 and 23, thus, considering that UEL courses range from 4 to 6 years to completion, all students have entered the program age.

Graph 6, for its part, presents data on the proportion (percentage) of students interviewed by country.

Graph 6– Nationality of PEC-G Students Interviewed



Fount: research questionnaire.

The students who participated in this research come from several countries, with different percentages. In relation to the students coming from Africa, the percentage index stands out with a greater number of students coming from the African continent. Following the presentation of the profile of the students interviewed, the answers to the questions (6) answered in the research questionnaire were analyzed.

In question 01, “**Why did you choose the PEC-G Program and the State University of Londrina to study for graduation?**”? a table summarizing the proportion (percentage) of the reasons for the Student-Graduation Agreement (PEC-G) and UEL program choices, considering the 26 (twenty-one) answers given:

Table 5 – Choice of PEC-G and UEL

Why did choose PEC-G?	QUA	%
Opportunity for new cultures and languages	11	42
Because they did not have the intended course in their country	6	23
The program offered good and free education	5	19
Suggestion from friends or relatives	2	8
It was the best option	1	4
To know Brazil	1	4
Why did choose UEL?	QUA	%
The program put them in UEL	11	42
For being a good university and of high prestige	8	30
Single University offering the intended course	3	12
For having friends at UEL	3	12

Already knew Londrina (city)

1 4

Fount: search data.

Thus, in the choices made, 11 (eleven) students, or 42% (forty-two percent) chose to participate because they had the opportunity to leave their country and to know new cultures and languages. However, 11 (eleven) students, making up, 42% (forty-two percent) did not even know about the existence of UEL. Thus, analyzing their responses, we perceive the need for visibility of UEL outside the country, creating, in this sense, digital media dissemination strategies in several languages of the PEC-G at the State University of Londrina, contributing to the increase in demand of students in the institution.

The reasons for the choices made by PEC-G and UEL in the responses of 13 students were: "The program offered good and free education" and "Because it is a good university and a high prestige."

In this context, according to the MRE (2015), culturally, coexistence and experiences tighten the bonds between societies, meaning a culture of knowledge integration between countries. Thus, one of the objectives of the G-PEC is cooperation with developing countries, creating a differentiated instrument of Public Policy (BIZON, 2013), in which the political-ideological commitment with these foreigners is to offer quality teaching and research. These, according to Stallieri (2002), together, create conditions of development, generating quality of life of the populations and academic knowledge for a good performance in their professional formation in their country.

In question 02, "**How is your experience in the country?**" the table summarizing the proportion (percentage) of satisfaction or non-satisfaction level is presented:

Table 6 – Country Experience

How is your experience in the country?	QUANTITY	%
Great, wonderful, good.	14	54
Good	10	38
There are good and bad times	1	4
It's not what I "thought it should be"	1	4

Fount: search data.

It is observed that the acquired experiences, although they are "great" and "good" by these students, among them there are also degrees of satisfaction and

dissatisfaction and concern:

Satisfaction: 1 (one) likes to live in Brazil; 3 (three) report that the people of their contacts are kind and friendly; 1 (one) reports that they are receiving quality education.

Dissatisfaction: 2 (two) students report various difficulties such as "xenophobia, racism and other forms of prejudice";

Preoccupation: 3 (three) students report difficulty in obtaining housing / lodging / guarantor (person who secures or ensures the fulfillment of duties and obligations of another).

Although the experiences acquired by these students are considered excellent, good and wonderful, some find it difficult to live, even though the Ministry of Foreign Affairs manual contains information that every student, on condition of participating in the Program, must prove that has financial conditions to remain at the place of exchange. In addition, it must declare that it has conditions to support itself.

Another major difficulty reported by them was socialization, as many reported racism and xenophobia as problems, this is a condition that involves common prejudice in today's society, the difficulty of living with differences and hurting attitudinal accessibility. According to this research, 34% (thirty-four percent) of the students of the UEL Program come from Africa, which leads to the conclusion that this nationality needs to achieve humanized and inclusive respect in the higher education. This reality demonstrates the validity of investing in Public Policies of insertion of the black in the university.

In question 03 "What are the main difficulties in adapting?" is presented the table that summarizes with proportion (percentage) the difficulties in the adaptation by these students of the 26 (twenty six) answers given:

Table 7 – Difficulties of adaptation

Difficulties of adaptation	Quantity	
Language, idiom	6	23
Habitation	4	15
Culture difference	4	15
Racism	3	12
Reception	1	4
Adapting to the course	4	15
Culture shock	2	8
Work - Not being able to work	1	4
They had no difficulties adapting	1	4

Fount: search data

With regard to the difficulties experienced by the exchange students, the question of language is mentioned, cited several times in their answers as a difficulty; 23% (twenty-three percent) have difficulty with the language and 15% (fifteen percent) with the dwelling. It is worth remembering that the Celpe-Bras proficiency exam is applied, according to the MRE, in the student's own country if there is an Applicator Center. Otherwise, the Program directs the student, in Brazil, where there is a vacancy to take the course and proof of proficiency. In this way, HEIs understand that the student should have at least an understanding and understanding of the Portuguese language in order to leverage their studies during the exchange.

However, according to the students' reports, one of the great difficulties experienced is related to the language, there is a need to review the evaluation tools and criteria, as well as access to learning Portuguese. Some HEIs are more structured than others, and it is necessary to invest more in preparatory courses of Portuguese for foreign students, including UEL, determining institutional actions with attention directed to the Portuguese courses, being it an application or not of the Celpe- Bras.

Another point reported by students on this issue is racism, notorious in several speeches of the students in this field work, because they realized racial and intercultural disrespect. Therefore, it is necessary to institutionally review how to adapt internal regulations of the University with the purpose of enabling the opportunity of appropriate treatment of diversity to foreign students.

In the matter 4, "What are the strengths and weaknesses of PEC-G?" the table summarizing with proportion (percentage) positive and negative points is presented, considering 26 (twenty-six) given answers:

Table 8 – Positive points of PEC-G

Regarding the answers:	Quantity	%
Opportunity new culture / study in Brazil	11	42
Good welcome	2	8
Quality education	4	15
Exchange of culture / exchange of experiences	6	23
Free Teaching	2	8
Enter University without taking a test	1	4

Fount: search data

Table 9 – Negative points of PEC-G

Regarding the answers:	Quantity	%
The diploma is withdrawn in the student's country;	1	4
Lack of assistance to students before arriving in Brazil;	1	4
Financial situation	4	15
Language idiom	11	42
Missing student reception;	2	8
Very strict PEC-G legislation	1	4
Not being able to work	1	4
Hangout	4	15
Can not transfer course or university	1	4

Font: search data.

Faced with the placement of 1 (one) student: "A negative point would be the possibility of changing course or university [which] does not occur in all cases, for example, in UEL do not accept change of internal course." It is noted that according to the Clause 15 Protocol, the transfer of the student-agreement from one institution to another is at the discretion of the institutions themselves, and can be accepted with justification of this claim, provided that it meets the requirements of the HEI of destination and always in conformity with the criteria set by the Education Board of the education system. That is, according to § 1, the transfer that refers to this clause is from one HEI to the other, provided that it is a participant in the PEC-G, to continue the studies in the same course. Thus, if the original HEI accepts the transfer, it can only be attended after the conclusion of the first year of studies, not occurring according to what the student says.

In relation to the positive points, 11 (eleven) students reported the opportunity to know a new culture, and the opportunity to study in Brazil. Likewise, these students, while in Brazil, offer the Brazilian university community opportunities for cultural and social exchange. Another positive point was: "This is a very good opportunity to receive a quality education", which implies strengthening the main objective of the Program, that is, focusing on relations between governments through quality education, contributing to the development of the countries agreed by training and professional qualification for foreign students.

In this sense, Decree 7948/13, which governs the PEC-G, establishes as some obligations of the student-covenant: Do not get involved in matters of Brazilian internal and external politics; to have sufficient financial resources to support maintenance in Brazil, such as food,

transportation, housing, teaching materials, etc.; dedicate themselves exclusively to studies; not engage in paid activity that establishes employment relationship.

Therefore, upon returning to the country of origin after completing the course, if he / she fails the proficiency examination and if he / she is disconnected from the Program by the IES due to disapproval or abandonment, the student must receive his academic documents, including diploma, at the Brazilian Diplomatic Mission where he enrolled in PEC-G.

What is observed, many times, is the non-compliance with this decree. Therefore, within the negative points reported, they have: "somewhat harsh clauses that do not take into account, for example, financial and health problems". In reality, in the financial question, the students suffer a lot, because in the reports of the previous questions, many complaints are verified in this sense.

Complaints are equivalent to saying that the decree does not always correspond to their reality: either they omit information at the time of filing, or the tutor of the country of origin fails to send the stipulated amount, or the political conditions of the country can be altered in the course of the student in Brazil. All this leaves the economic condition of these students to be desired, hindering them in all aspects: housing, food, and finally, their costs in Brazil.

On the other hand, these same students do not always officialize their difficulties; the government offers Bolsa Merit and Emergency Grant, but they have to compete for them; in turn, the University offers non-curricular or non-compulsory internships that, according to Law 11.788 / 2008, must be remunerated; they can still check in their study centers possibilities of extension projects and paid education.

In addition, another fact reported was the "[...] lack of assistance to students before arriving in Brazil (with basic information such as stay and expenses in the region)." In the Student-Covenant Handbook, there is an item called "Travel Arrangements", one of the items being the address of an electronic page7 that contains information about Brazilian cities, in which the student can search for rent, bus, hotel etc., but this site only exists in the Portuguese language, making it difficult for those who are foreign and do not speak the language.

In addition, UEL has a Facebook page to publicize PEG-G's actions within the Institution, 8 in this way, students can check information on these social networking channels. For example, in this social network, a request for stay and help to search the bus station / airport for six students who would enter the year 2017

was announced, as well as an event about student stay and diversity. Therefore, there is a wealth of information that students can use for the purpose of entering the university context.

In the matter 5, “How do you evaluate the services provided by the State University of Londrina in relation to Infrastructure and Education”? the table summarizing the proportion (percentage) of the infrastructure question is presented, twenty-four (24) students answered, while two (2) failed to answer this question:

Table 10 – Infrastructure

Infrastructure	QUANTITY	%
Great, very good, good, normal	15	57
Old Computers and the poor Internet	4	15
Moderate	1	4
Ru – Very good university restaurant	1	4
Deplorable	1	4
Precarious	2	8
They did not answer	2	8

Fount: search data.

In terms of infrastructure: 15 (fifteen) students, that is, 57% (fifty-seven percent) of the students considered the structure to be optimal or good; 1 (one) student, that is, 4% (four percent) considered the university restaurant very good; 4 (four) students, or 15% (fifteen percent) complained about the quality of computers and Internet signal; 1 (one) student, that is, 4% (four percent) stated that the infrastructure is deplorable; 1 (one) student, that is, 4% (four percent) stated that the infrastructure is reasonable; 2 (two) students, that is, 8% (eight percent) declared the infrastructure to be precarious; 2 (two) students, that is, 8% (eight percent) did not respond. Infrastructures are points that need to be revised in order to contribute to the well-being of students, with adequate environment and digital accessibility.

In question 6, regarding the quality of teaching, “How do you evaluate the services provided by the State University of Londrina in relation to Teaching”? is presented the table that synthesizes with proportion (percentage) the evaluation of the teaching:

Table 11 – Education

Evaluate Teaching	QUANT %	ITY
Good	10	38
Optimum	3	12
Excellent	1	4
Good teachers / good	4	15
Not satisfied	3	12
Bad	1	4
Unprepared Teachers	4	15

Fount: search data.

In the teaching question: 10 (ten) students, or 38% (thirty-eight percent) answered that teaching is good; 3 (three) students, or 12% (twelve percent) considered the teaching optimal; 1 (one) student, that is, 4% (four percent) said that teaching is excellent.

In this aspect, it is necessary to consider that the University fulfills its role, offering quality of education by disseminating knowledge, since three (3) found the teaching to be good and responded by believing that when they graduate from UEL, they will leave with a good quality education, as well as considered the teaching staff of great quality. However, the student who declares "excellent" teaching believes that he does not leave the institution fully prepared for the job market, but that the university, with its academic training, opens many doors and that, with the strike, lost important contents.

Thus, at the same time that one perceives a good quality teaching, one notices that for some, teaching fails to be desired, when they affirm that, even teachers being "great", there are difficulties of understanding by cause of language, which makes learning difficult. Meanwhile, others have reported that "teaching leaves much to be desired," teachers "are not really prepared to teach some subjects." However, according to the PDI (2010-2015), the collegiate course, together with the Dean of Graduation, allows the training of PEC-G students with varied academic systems, with innovations and versatility in the curricular matrices.

In view of the above, we return to the question of reception and follow-up of these students, periodically checking their needs, creating means for students to overcome difficulties, that is, creating institutional welfare policies.

Regarding Teaching, in question 07, "In your opinion what could improve"? is presented the table that synthesizes with proportion (percentage) on what could improve:

Table 12 – Could Improve

What could improve?	QUANTIT %
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	Y	
- Strike - difficulty	2	8
- Visa renewal - bureaucracy / very high rate value	3	12
- The physical structure of the dental clinic	1	4
- More scholarship funds for PEC-G students	2	8
- Student unable to work - could review this issue (Law)	1	4
- Master's degree short-term graduation opportunity	1	4
- Make housing / UK available without selection process	1	4
- Disseminating PEC-G in the university community	1	4
- Review rules for shutdown	1	4
- In the case of UEL improving infrastructure and the PEC-G Program	1	4
- Improve the surveillance / security of the Institution	1	4
- It does not need improvement - "[...] so far, everything is fine."	1	4
- Preparation of teachers to deal with differences	1	4
- Should have more staff to deal with the G-PEC issue	1	4
- Social integration: Formal presentation students to course / language / information coordinators about housing, food, lodging / language (difficult to communicate) / racism and xenophobia / services site offered by UEL, legal and psychological support.	7	28

Font: search data.

What attracted the most attention in this item is social integration, making up a total of 28% (twenty-eight percent) of the students, highlighting some reports: communication difficulties, formal presentation to course coordinators, racism and xenophobia and legal and psychological support. However, it is noteworthy that UEL has made available these last services to the PEC -G students.

In addition, the report of 1 (one) student: "They could take the agenda of the agreement where the exchange student is forbidden to work". However, it

should be noted that the student of the PEC-G, due to the temporary visa (item IV), cannot really exercise paid activity that establishes employment relationship. However, the student may participate in curricular internship, research, extension and monitoring activities.

In general, analyzing the answers and opinions of the various students of the research, it can be observed that, for the great majority, the questions stand out: housing (that is, how to obtain a guarantor); language (how to understand and be understood); legal issues of racism, xenophobia (how to deal with such issues); presentation of students to collegiate courses for a better integration of these students; visa bureaucracy, PEC-G fellowship issues. With this, it can be stated that what is established in the decree does not always correspond to the experience of these students, after all the students of the PEC-G come to the University and there is no institutional policy to welcome these students of vulnerability.

In this way, it is possible to affirm that, when participating in the Program of Students-Graduation Agreement (PEC-G), the majority of these students, when they enter the University to attend the course in their chosen course, remain determined, remaining in the Institution and forming, even if feeling vulnerable and having to face some mishaps. Thus, they value the opportunity and the studies and the chance to have a profession in the return to the country of origin.

In general, it was also observed, during the analysis of this work, that there is little knowledge about the Program, both by the students and by the professionals involved, and it can be concluded that there is a need for institutional actions to publicize the Program. In order to make a policy, be it social, welfare, etc., it is necessary to join the services and servers instituted in the UEL within the Program and join efforts to work within the principles of ethics and socialize information, seeking the profile of this public with the objective of identify their needs, their needs. Thus, in order to make a policy, it is necessary to work together, in collaboration, in order to obtain satisfactory results with the Program within the University.

V. CONCLUSIONS

With the data gathered from the research, one can better understand the proposal of the Program and its operation in the institution, as well as, through questionnaires and interviews, one can evaluate what was said by the social actors involved. Among the students' responses, the choice of G-PEC was highlighted because of opportunities for new cultures and languages, a free

study and a prestigious university, although, in contrast, 42% (forty-two percent) of the students interviewed not meet the UEL before choosing it.

Certain difficulties in adaptation found in the reports, which constitute issues to be thought, were: housing, socialization, racism and xenophobia, according to research data. Of particular note are the language problems, where 23% (twenty-three percent) said they had difficulty with the language, while 15% (fifteen percent) with the dwelling.

Evaluating the responses, it was verified the need for UEL visibility in the country and abroad, suggesting the creation of mechanisms to disseminate the institution in digital media in several languages. And, once these mechanisms of visibility of the University and the PEC-G were created, it is assumed that there would be an increase in the demand of these students to graduate in UEL.

In the analysis of the questionnaires answered by the students, it was noticed that, when arriving in Brazil, in Londrina, and specifically in the UEL, students already feel the cultural shock and difficulties in the language, as well as changes in the food habit, difficulties of housing, so that these mishaps have contributed to the vulnerability of these students.

Education, as a right of all citizens, is a public function of the State, according to the constitution in force, however it is not only up to it, and, in the students' reports, it was observed that the fact that they did not feel inserted in the academic context makes it difficult to learn. In this case, the Institution must guarantee equal treatment in the university context, contributing to the student's academic and cultural training.

In the context of the political situation of vulnerable PEC-G students, the Institution should create a committee that works with the relevant sectors, offering possibilities to those students who have difficulties in learning. However, it is worth mentioning that there is no point in discussing Public Policy if the one who experiences the problem is not part of the discussion, that is, if the social service professional and the psychology professional, together with the relevant Rectors and Advisers to evaluate these not interact with the competent bodies to read the real situation of these students.

REFERENCES

- [1] BRAZIL. Ministry of Education. Access to the University - Foreign student. 2015. Available at: <www.mec.gov.br>. Accessed on: 14 Feb. 2016.
- [2] Ministry of Education - Capes. International Baccalaureate Program - PLI - CAPES, 2014 - FRANCE EDITAL N°. 05/2014. 2014b.
- Available at: <<http://capes.gov.br/images/stories/download/editais/2612015-05-2015-PLI-franca.pdf>> Access: January 14. 2017.
- [3] Ministry of Education. Access to the University - Foreign student. 2015. Available at: <www.mec.gov.br>. Accessed on: 14 Feb. 2016.
- [4] BIZON, Ana Cecilia Cossi. Narrating the Celpe-Bras exam and the PEC-G agreement: the construction of territorialities in times of internationalization. 2013. 415 f. Thesis (Ph.D. in Applied Linguistics) - State University of Campinas, SP, Campinas, 2013. Available at: <<http://unicamp.sibi.usp.br/handle/SBURI/30788>>. Access in: Jan. 13 2016.
- [5] Division of Educational Issues (DCE, 2016) [FALTA ESTA REFERÊNCIA]
- [6] DUARTE, Rafael P. United Nations Educational, Scientific and Cultural Organization (UNESCO). Ministry of Education (MEC). Secretariat of Higher Education (SESu). Department of Graduate Programs and Policies (DIPES). [FALTA DADOS, COMO O ANO]
- [7] GIL, Antonio Carlos. Methods and techniques of social research. 6. ed. São Paulo: Atlas, 2008.
- [8] HÖFLING, Eloisa de Mattos. State and (public) social policies. Cadernos Cedes, Campinas, v. 21, n. 55, p. 30-41, nov. 2001. Available at: <<http://scielo.br/pdf/ccedes/v21n55/5539>>. Accessed on: 17 Oct. 2016.
- [9] MACIEL, C. A. B. Public Policies and Social Control: meetings and disagreements of the Brazilian experience. Revista Intercâmbio de Congressos de Humanidades, v. 1, n. 1, 2010. Available at: <revisor10.com.br/24h/pessoa/temp/anexo/1/112/1184fb6636800a0a.doc>. Accessed on: 15 Aug. 2016.
- [10] SOUZA C. Public Policies: a literature review. Revista Sociologias, Porto Alegre, year 8, n. 16, Jul / Dec 2006.
- [11] STRECK, Lênio Luiz; MORAIS, José Luís Bolzan. Political Science and General Theory of the State. Porto Alegre: Bookstore of the Lawyer, 2000.

Tratamentos Pré Germinativos Na Germinação De Sementes De Cacau

Pre Germinating Treatments on Germination of Cocoa Seeds

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Resumo— O conhecimento das condições ideais para germinação da semente é fator importante para que possamos garantir uma produção uniforme de mudas de qualidade com garantia de estabelecimento do stand no campo de produção. Objetivou-se avaliar diferentes tratamentos térmicos, hormonal e nutricional na germinação e vigor de sementes de cacau (*Theobroma cacao* L.). O experimento foi conduzido no Laboratório de Sementes do IFES Campus - Santa Teresa e os tratamentos utilizados foram imersão durante 30 minutos em água nas temperaturas de 0°C, 25°C, 50°C, 75°C, água de coco; solução de cloreto de potássio e solução de giberelina. Cada tratamento foi composto de 4 repetições, com 25 sementes por repetição. Avaliou-se a porcentagem de germinação, índice de velocidade de germinação; tempo médio de germinação e o vigor das sementes foi avaliado por meio do comprimento de parte aérea e de radícula, matéria fresca e matéria seca das plântulas. Os tratamentos térmicos que proporcionaram os melhores resultados de vigor nas sementes de cacau respectivamente foram imersão em água a 50°C e água a 25°C. O tratamento com imersão em solução de giberelina (2000 mg.L⁻¹) 30 minutos, apresentou os melhores resultados, sendo recomendado para semente de cacau.

Palavras chave— Vigor. Plântula. Laboratório.

Abstract— Knowing the ideal conditions for seed germination is an important factor so that we can guarantee a uniform production of quality seedlings with guarantee of establishment of the stand in the field of production. The objective was to evaluate different thermal, hormonal and nutritional treatments on the germination and vigor of cocoa seeds (*Theobroma cacao* L.). The experiment was conducted in the Seeds Laboratory of the IFES Campus - Santa Teresa and the treatments used were immersion for 30 minutes in water at temperatures of 0 ° C, 25 ° C, 50 ° C, 75 ° C, coconut water; solution of potassium chloride and gibberellin solution. Each treatment was composed of 4 replicates, with 25 seeds per replicate. The percentage of germination, germination speed index; mean germination time and seed vigor was evaluated by aerial part length and radicle, fresh matter and dry matter of the seedlings. The heat treatments that gave the best results of vigor in the cocoa seeds respectively were immersion in water at 50°C and water at 25°C. The treatment with immersion in gibberellin solution (2000 mg.L⁻¹) 30 minutes, presented the best results, being recommended for cocoa bean.

Keywords— Vigor. Seedling. Laboratory.

I. INTRODUÇÃO

Originário da América Central e do Sul, o cacauzeiro (*Theobroma cacao* L.) é uma árvore tropical e de clima úmido, que produz anualmente de 0,5 a 2 kg de sementes, já fermentadas e secadas, por árvore (Medeiros et Al. 2010). Tem um valor econômico bastante relevante, pois através do cacau é feito o chocolate, por meio da moagem de suas amêndoas secas em processo industrial ou caseiro, gerando também outros subprodutos com a polpa, tendo os seus resíduos utilizados como adubo e ração para os animais.

Pertence à ordem Malvales, família Malvaceae, gênero *Theobroma*, espécie *Theobroma cacao* L., única utilizada comercialmente para a produção de chocolate. Os astecas e outros grupos de língua nahuatl denominavam o cacauzeiro de “cacaohoaquahuitl”, os frutos de “cachocentli” e suas sementes de “cacaoatl”, nome utilizado atualmente para a espécie. Em 1737, Lineu denomina o gênero de *Theobroma*, que significa alimento dos deuses, em referência à origem divina atribuída ao cacauzeiro pelos povos mesoamericanos (Efraim, 2009; Lopes et al, 2011).

O fruto do cacaueteiro tem forma oval com 15 a 20 cm de comprimento do eixo maior, e cor amarela quando maduro. O cotilédone e um pequeno gérmen de planta embrionária são recobertos por uma película denominada testa, e a semente é revestida por uma polpa branca com tons rosados, mucilaginososa e adocicada (Batalha, 2009).

Planta de clima quente e úmido o cacaueteiro pode ter sua propagação de forma vegetativa (assexuada) e por sementes (seminal/ sexuada). A qualidade das sementes, bem como a capacidade de produzir plântulas normais, é expressa pelo teste de germinação. Cada espécie exige determinadas condições de germinação, nas quais suas sementes conseguem expressar o máximo potencial de vigor (Garcia, 1994).

As sementes desenvolveram métodos eficientes, ao longo do tempo, não somente sensores capazes de sentirem o ambiente a sua volta, mas também o seu histórico de desenvolvimento evolutivo que são capazes de regular a sua dormência fisiológica e a inibição da germinação (Kendallet et al., 2011; Kendall & Penfield, 2012; Penfield & Springthorpe, 2012; He et al., 2014; Huang et al., 2014) tais sinais vão determinar o tempo e o local de germinação das sementes (Footitt et al., 2011, Footitt et al., 2013, Footitt et al., 2014). Sendo uma semente recalcitrante o cacauete tolera apenas uma pequena perda de água através de secagem e apresenta taxa de germinação moderada na ausência de água adicional.

O processo germinação de sementes de um mesmo lote pode estar em diferentes fases da curva de embebição, fazendo com que a germinação não aconteça de forma homogenia. Uma pré-embebição em água ou em uma solução de potencial osmótico conhecido, durante intervalo de tempo e temperatura determinados, permiti o controle da disponibilidade hídrica, (Tonin, 2005) sendo uma forma de acelerar o processo de germinação.

O conhecimento das condições ideais para germinação da semente é fator importante para que possamos garantir uma produção uniforme de mudas de qualidade com garantia de estabelecimento do stand no campo de produção.

O objetivo da pesquisa foi avaliar a germinação e o vigor das sementes de cacauete em diferentes tratamentos térmico, fontes de nutrientes e hormonal.

II. MATERIAL E METODOS

O experimento foi conduzido no Laboratório de Tecnologia e Produção de Sementes do Instituto Federal do Espírito Santo *Campus* - Santa Teresa que se localiza na Região Centro Serrana do Estado de Espírito Santo.

Os frutos da variedade clonal PS-1319 foram adquiridas na fazenda experimental da CEPLAC,

localizada no município de Linhares. Foi realizada a extração das sementes, imersas em uma solução de cal virgem durante 1 minuto e depois enxaguadas em água corrente, para retirar o excesso da mucilagem. Logo após, as sementes foram colocadas em contato com uma mistura contendo pó de serra e areia, e friccionando com cuidado para retirada do restante da mucilagem, lavando-as novamente para retirar a mistura.

As sementes foram postas sobre folhas de jornal e colocadas para secar a sombra durante o período de 24 horas.

O Delineamento experimental utilizado foi em blocos casualizados onde os tratamentos foram compostos por diferentes temperaturas, 0°C, 25°C, 50°C, 75°C, tratamento nutricional com solução de cloreto de potássio (50 g.L⁻¹) e água de coco, tratamento hormonal com solução de ácido giberelina (2000 mg.L⁻¹). O tempo de imersão das sementes foi fixado em 30 minutos para todos os tratamentos. Foi utilizado quatro repetições de cada tratamento, no qual cada amostra de continham 50 sementes distribuída entre três folhas de papel germitest umedecida com água destilada, equivalente a duas vezes e meia o peso do substrato seco, colocados em BOD a 25°C, com presença de luz.

O teste de germinação foi conduzido conforme Brasil (2009), sendo a primeira avaliação da germinação realizada aos quatro dias, avaliando-se diariamente para obter a porcentagem de germinação (G), índice de velocidade de germinação (IVG) (Maguire, 1962); tempo médio de germinação (TMG) (Laboriau & Valadares, 1976). O vigor das sementes foi avaliado por meio do comprimento de parte aérea (CA) e de radícula (CR), matéria fresca (MFP) e matéria seca das plântulas (MSP).

Os dados experimentais foram submetidos à análise de variância, atendendo as pressuposições do modelo pelo teste de Shapiro-Wilk para verificação da normalidade e as médias dos tratamentos foram comparadas pelo teste Tukey em nível de 5% de probabilidade.

III. RESULTADOS E DISCUSSÃO

Nos tratamentos em que as sementes foram embebidas em diferentes temperaturas, observou-se que houve diferença significativa entre as mesmas, sendo apenas os tratamentos com água a 25°C e 50°C apresentaram maior representatividade, mostrando a influência da temperatura na germinação (Tabela 1). Os valores no que dizem respeito ao Índice de velocidade de germinação, e Tempo médio de germinação também demonstram os mesmos resultados com diferença significativa em relação aos outros tratamentos térmicos.

O comportamento nos tratamentos com temperaturas de 0°C e 75°C, não apresentaram resultados satisfatórios nos testes ligados a germinação. Como a temperatura vai aos extremos nesses tratamentos, danos nas membranas e no funcionamento nas sementes podem ter acontecidos. As altas temperaturas podem ter afetado os tecidos do eixo embrionário, com consequências que podem ter culminado na redução da germinação ou até mesmo, na morte do embrião. Os resultados obtidos nas temperaturas de 25 e 50°C demonstram que o tempo de embebição das sementes favoreceu no desempenho da germinação das sementes de cacau.

Brancaion et al. (2010), trabalhando com espécies arbóreas, cita que a temperatura de 25 °C é ótima para a germinação das sementes da maioria das espécies arbóreas brasileiras, seguida por 30 °C. Analisadas em

conjunto, as temperaturas 25 °C e, ou, 30 °C representaram 90,4% das indicações de temperaturas ótimas para a germinação das sementes, de forma que as mesmas puderam ser consideradas como as que mais favorecem o processo germinativo das espécies.

Carreiro et al. (2010) verificaram que os tratamentos com água quente à 50°C e à 60°C promoveram uma maior porcentagem de germinação e maior uniformidade; já a 70°C houve uma queda no percentual de germinação.

Quando utilizamos tratamentos hormonais ou com fontes de nutrientes, não foi observada diferença significativa para germinação, porém a giberelina apresentou-se IVG e TMG com os maiores tempos na velocidade de germinação e menores no tempo médio de germinação (Tabela 1).

Tabela 1 – Média dos tratamentos para germinação e vigor em sementes de cacau

Trat	G	IVG	TMG	CA	CR	MFP	MSP
1	38 bc	1,536 c	7,709ab	3,81 ab	25,79 a	3,686 h	9,48 h
2	98 a	4,454 a	6,628bc	5,69 a	26,46 a	44,022 d	10,24 c
3	100 a	4,824 a	6,18 bc	5,9 a	27,78 a	44,784 b	10,66 b
4	58 b	2,883 b	5,949 c	5,41 a	25,2 a	44,556 c	9,52 g
5	98 a	4,379 a	6,960 bc	0,65 bc	12,05 b	35,758 f	9,96 e
6	100 a	3,286 b	8,52 a	0,6bc	9,33 b	32,504 g	9,57 f
7	100 a	4,866 a	6,117 bc	5,5 a	23,21 a	51,190 a	11,17 a

Médias dos tratamentos, seguidas da mesma letra na coluna para cada variável, não diferem entre si pelo teste Tukey em nível de 5% de probabilidade.

G = Germinação (%); IVG = Índice de Velocidade de Germinação; TMG = Tempo Médio de Germinação; CP = Comprimento da parte aérea; CR = Comprimento de Raiz; MFP = Matéria Fresca da Planta; MSP = Matéria Seca da Planta. Trat. 1 = Água 0°C; Trat. 2 = Água 25°C; Trat. 3 = Água 50°C; Trat. 4 = Água 75°C; Trat. 5 = Água de Coco; Trat. 5 = Cloreto de Potássio; Trat.7 = Giberelina.

Quando analisado os dados que dizem respeito ao vigor das sementes que foram tratadas com as diferentes temperaturas de água através dos valores de comprimento da parte aérea e comprimento da raiz, os tratamentos nas diferentes temperaturas e com giberelina não apresentaram diferença significativa entre si, porém o tratamento com água de coco e cloreto de potássio apresentaram-se bastante inferiores aos demais tratamentos (Tabela 1).

As variáveis Massa Fresca e Massa Seca da Planta foram superiores no tratamento com Giberelina, comparado aos outros tratamentos. A Água de Coco apesar de ter proporcionado uma boa germinação, foi insatisfatória nas outras avaliações, ainda que esta, com características hidratantes, não foi bem assimilada pela semente de cacau.

O Tratamento com água 0°C (gelo), não apresentou bons resultados para semente de cacau, fato

que deve ser citado como desaconselhável para semente de cacau.

O ácido giberélico possui extrema importância na germinação por agir na quebra de dormência controlando a hidrólise de reservas que estão relacionadas ao crescimento e desenvolvimento do embrião, comprovando os melhores resultados encontrados neste trabalho.

Guimarães et al. (2010) trabalhando com sementes de *Thlaspi caerulescens* J. Presl & C. Presl demonstraram que o uso de GA3 foi benéfico, por promover maiores porcentagens de germinação e maiores índices de velocidade de emergência. Também Peixoto et al. (2011) encontraram resultados positivos quando aplicada na pré-embebição de sementes de mamona, estimulando a porcentagem de primeira contagem de emergência, índice de velocidade de emergência e porcentagem de emergência, além de

proporcionar incremento significativo no comprimento de raiz e de parte aérea, bem como no acúmulo de massa seca da raiz, parte aérea e total das plântulas.

Prado (2006) observou que a pré- embebição de sementes de jenipapeiro por 12 horas em solução de giberelina nas concentrações de (50, 100 e 200 mL.L⁻¹), proporcionam maiores índices de velocidade de germinação de sementes. Santos Filho (2007) cita que o índice de velocidade de germinação e o índice de velocidade de emergência em sementes de graviola, foram aumentados com o uso da solução de giberelina.

Prado (2006) verificou que o regulador à base de ácido giberélico foi eficiente na indução do comprimento de raiz e comprimento total de plântulas de jenipapeiro. Na cultura do milho, a aplicação de giberelina (GA3) pulverizado sob as plantas de milho normal e anão, ocasionou o alongamento das plantas de milho anão e, conseqüentemente, aumento da estatura (Taiz & Zeiger, 2013).

IV. CONCLUSÃO

Os tratamentos térmicos que proporciona os melhores resultados de vigor nas sementes de cacau respectivamente foram imersão em água a 50°C e água a 25°C por 30 minutos.

O tratamento com imersão das sementes em solução de ácido giberélico-Ga3(2000 mg.L⁻¹) 30 minutos, apresentou os melhores resultados, sendo recomendado para semente de cacau.

REFERÊNCIAS

- [1] BATALHA, P. G. **Caracterização do cacau Catongo de São Tomé e Príncipe**. Lisboa. Mestrado (Mestre em Engenharia de Alimentos – Tecnologia de Produtos vegetais) Universidade Técnica de Lisboa. Instituto Superior de Agronomia. Lisboa – Portugal, 2009.
- [2] BRANCALION, P. H. S.; NOVENBRE, A. D. L. C.; RODRIGUES, R. R. Temperatura ótima de germinação de sementes de espécies arbóreas brasileiras. **Revista Brasileira de Sementes**, Londrina, v.32, n.4, p.15-21, 2010.
- [3] BRASIL. Ministério da Agricultura. **Regras para análise de sementes**. Brasília, 2009. 398 p.
- [4] CARNEIRO, G. G.; BARBOSA, J. A.; SILVA, E. O.; GOIS, G. C.; LUCENA, H. H.; ALVES, E. U. *Bioscience Journal*, Germinação de pimentas cambuci submetidas à superação de dormência em água quente. Uberlândia, v. 26, n. 6, p. 882-885, Dez. 2010.
- [5] EFRAIM, P. **Contribuição à melhoria de qualidade de produtos de cacau no Brasil, através da caracterização de derivados de cultivares resistentes à vassoura-de-bruxa e de sementes danificadas pelo fungo**. Campinas. Tese (Doutorado em Tecnologia de Alimentos). Faculdade de Engenharia de Alimentos, Universidade Estadual de Campinas, 2009.
- [6] FOOTITT, S.; DOUTERRELO-SOLER, I.; CLAY, H.; FINCH-SAVAGE, W.E. Dormancy cycling in Arabidopsis seeds is controlled by seasonally distinct hormone-signaling pathways. **Proceedings of the National Academy of Sciences, USA** 108, 20236– 20241, 2011.
- [7] FOOTITT, S.; HUANG, Z.Y.; CLAY, H.A.; MEAD, A.;FINCH-SAVAGE, W.E. Temperature, light and nitrate sensing coordinate Arabidopsis seed dormancy cycling, resulting in winter and summer annual phenotypes. **Plant Journal**, 74, 1003– 1015, 2013.
- [8] FOOTITT, S.; CLAY, H.A.; DENT, K. ;FINCH-SAVAGE, W.E. Environment sensing in spring-dispersed seeds of a winter annual Arabidopsis influences the regulation of dormancy to align germination potential with seasonal changes. **New Phytologist**, 202, 929–939, 2014.
- [9] GARCIA, L. C. Influência da temperatura na germinação de sementes e no vigor de plântulas de cupuaçuzeiro (*Theobroma grandiflorum* (Wild. Ex-Spreng) Schum.). **Pesquisa Agropecuária Brasileira**, V29, n. 7, p. 1145-1150, 1994.
- [10] GUIMARÃES, M.A.; VIDIGAL, D. S.; LOUREIRO, M. E.; DIAS, D. C. F.S.; GUIMARÃES, A. R. Influência de temperatura, luz e giberelina na germinação de sementes de *Thlaspi caerulescens* J. Presl & C. Presl (Brassicaceae) **Revista Ceres**, Viçosa, v. 57, n.3, p. 372-376, mai/jun, 2010.
- [11] HE, H.; DE SOUZA VIDIGAL, D., SNOEK, L.B.; SCHNABEL, S.; NIJVEEN, H.; HILHORST, H. ; BENTSINK, L. Interaction between parental environment and genotype affects plant and seed performance in Arabidopsis. **Journal of Experimental Botany**, 65, 6603–6615, 2014.
- [12] HUANG, Z.; FOOTITT, S.;FINCH-SAVAGE, W.E. The effect of temperature on reproduction in the summer and winter annual Arabidopsis thaliana ecotypes Bur and Cvi. **Annals of Botany**, 113, 921– 929, 2014.
- [13] KENDALL, S. ; PENFIELD, S. Maternal and zygotic temperature signalling in the control of seed

- dormancy and germination. **Seed Science Research**, 22, S23–S29, 2012.
- [14] KENDALL, S.L.; HELLWEGE, A.; MARRIOT, P.; WHALLEY, C.; GRAHAM, I.A.; PENFIELD, S. Induction of dormancy in Arabidopsis summer annuals requires parallel regulation of DOG1 and hormone metabolism by low temperature and CBF transcription factors. **Plant Cell**, 23, 2568–2580, 2011.
- [15] LABOURIAU, L. G.; VALADARES, M. E. B. On the germination of seeds *Calotropis procera*(Ait.). **Anais da Academia Brasileira de Ciências**, v.48, n.2, p.263-284, 1976.
- [16] LOPES, U. V.; MONTEIRO, W. R.; PIRES, J. L.; CLEMENT, D.; YAMADA, M. M.; GRAMACHO, K. P. Cacao breeding in Bahia, Brasil - strategies and results. **Crop Breeding and Applied Biotechnology**, v. 1, p. 73-81, 2011.
- [17] MAGUIRE, J. D. Speed of germination – aid in selection and evolution for seedling emergence and vigor. **Crop Science**, v.2, n.2, p.176-177, 1962.
- [18] MEDEIROS, M. L.; LANNES, S. C. S. Propriedades físicas de substitutos do cacau. **Cienc Tecnol Aliment**, v. 30, n. 1, p. 243-53, 2010.
- [19] PEIXOTO, C. P.; SALES, F.J. S.; VIEIRA, E. L.; PASSOS, A. R.; SANTOS, J. M.S. Ação da giberelina em sementes pré-embebidas de mamoneira. **Comunicata Scientiae**, Teresina 2(2): 70-75, 2011.
- [20] PENFIELD, S. ; SPRINGTHORPE, V. Understanding chilling responses in Arabidopsis seeds and their contribution to life history. *Philosophical Transactions of the Royal Society B – Biological Sciences*, 367, 291–297, 2012.
- [21] PRADO, M. **Germinação de sementes e enxertia de jenipapeiro**. 46f. (Dissertação de Mestrado) – Universidade Federal da Bahia, Cruz das Almas, Brasil. 2006.
- [22] SANTOS FILHO, A. L. **Germinação de sementes, estaquia e enxertia em gravioleira** (*Annona muricata* L.). 50f. (Dissertação de Mestrado) – Universidade Federal da Bahia, Cruz das Almas, Brasil. 2007.
- [23] TAIZ, L.; ZEIGER, E. **Giberelinas**: reguladores da altura dos vegetais. *Fisiologia vegetal*. 5.ed. Porto Alegre: Artmed: 2013. 488p.
- [24] TONIN, G. A. et al. Influência da temperatura de condicionamento osmótico na viabilidade e no vigor de sementes de *Pterogyne nitens* Tull. **Revista Brasileira de Sementes**, Londrina, v. 27, n. 2, p. 35-43, 2005.

Introduction of Agro-Ecological Systems in the Municipality of Exu-Pe

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Abstract— *Agroecology has led us to think a lot far beyond the immediate results of our actions, and it makes us reflect on what they mean about all beings that share the same environment, breathe the same air and share a unique biosphere. Based on agroecological principles, organic farming yields food without toxic waste, guaranteeing a healthy diet in our homes. It is necessary to consider that agroecology is a practice that does not affect the health of the farmers or the ecosystems. This paper presents bibliographic research regarding the questions about agroecology, its characteristics, and the importance of the action of man in work with the practice in question. It aims to achieve a better quality of life in the environment in which we live, as well as healthy nurture, caring for the environment, preserving the ecosystem, making more understandable the importance of agroecology for the quality of life of a society.*

Keywords— *Agroecology, Life quality, Semiarid zones*

I. INTRODUCTION

The main objective of this work is to verify which agro-ecological practices are carried out in the municipality of Exu-PE, in the region of Chapada do Araripe. The central focus of the analysis will be to verify whether the methods used to present an agroecological production.

The origin of this problem is related to the observations of the methods of agricultural production in the city. Since the main foundation of agroecology is to cultivate agriculture that does not affect the environment, but instead develops mutually, so that one favors the other as opposed to conventional agriculture. In this way, I intend to investigate whether there has been a change in the production methods used in the Lermen family's estate.

With this study, we intend to understand and explain the scenario of agroecological production in the semiarid region, addressing aspects related to the climate of the Chapada (plateau) do Araripe. The study was conducted through bibliographic research and brought a record of agricultural production methods from the beginning to the recent agroecology. The emergence of agroecology took place through the evolution of the thoughts and concerns of the people involved in activities related to the environment, to the soil and the agriculture as a whole (ASSIS, 2006).

In the Brazilian context, the concept of agroecology

emerged through the creation of non-governmental organizations in the early 80s years. Nowadays, this concept is present in all regions of the country, especially among small communities, in addition to involving a considerable amount of scientists, academics and scholars from various areas (Santos *et al.*, 2014).

Regarding the semiarid region, social representations most often appear associated with a hostile and inadequate landscape for any productive activity. However, when considering this environment in a more attentive way, despite the climatic seasonality existing in the eco-regions, there is a broad biological potentiality of the agroecosystems that are composed in the caatinga biome. In this biome, the main problem is the scarcity of water, and so the crops are so impaired (VIEIRA-FILHO, *et al.*, 2016).

In the municipality of Exu, some communities practice agroecology. Among them is Baixo do Meio, Serra do Ingá and Serra da Refrigera with a production, basically of vegetables and fruit trees. However, the community with the highest expressiveness is the Lermen family, in the Serra (mountain) dos Paus Doías. Another aspect that is addressed in the text is the influence of civil society organizations, for the implementation of agroecology in this region.

II. AGROECOLOGY IN BRAZIL

Agroecology can be understood as the ecological

management of natural resources, through forms of collective social action, participative development from production to the final product, establishing relationships between production and consumption. In this sense, agroecology does not exist alone, since it is integrating science, aggregating knowledge of other sciences, such as ecology, available expertise and traditional knowledge from the experiences of rural farmers (CAPORAL, 2004).

It is important to emphasize that the primary foundation of agroecology is to plant, which does not affect the environment, developing mutually one favoring the other, unlike conventional agriculture that considers little for the environment (CAPORAL, 2007).

Agroecology emerged in the decade of 1970, to constitute a theoretical basis for different movements of alternative agriculture that were strengthening with the exhaustion of modern agriculture. Although the term has arisen along with the various currents of alternative farming, it cannot be understood as an agricultural method. Agroecology is a science that seeks to understand the functioning of complex agroecosystems, as well as the different interactions found in them, with the main foundation of preserving and expanding the biodiversity of Agricultural systems as support to produce self-regulation and therefore sustainability (ASSIS, 2005).

III. UPRAISING OF AGROECOLOGY IN BRAZIL

Agriculture has always been part of the observations of people seeking improvements in the exercise of the activity. Thus, it causes an actual process of accumulated information making agricultural technologies evolving and diminishing environmental constraints (ASSIS, 2006).

Since the colonial period, problems related to the environment have been observed, more specifically deforestation and soil conservation, caused by the production system in monoculture systems. According Aurelio's dictionary: "*monoculture is the exclusive culture of an agricultural product.*" Although people were aware of the environmental degradation caused by this specific mode of production only in the mid-60 and 70, they decided to seek solutions to these ecological problems (DE DEUS; BAKONYI, 2012). In this context, Assis (2005) elucidates that, from the characterization of these problems, alternative farming movements to the currently predominant production model ceased to elicit in their opponents the relentless discourse that would represent a return to the past.

Even during those decades, it is possible to identify the initial concerns regarding environmental preservation.

From there it has increased the fears of the inclusion of anthropogenic activities with soil, fauna, water resources, flora, and ecosystems, forcing these activities not to cause irreparable losses to the environment and result in safe food for those involved in this process (MONASTÉRIO; MELO; SOARES, 2014).

At this point, it is evident that the emergence of agroecology took place through the evolution of the thoughts and concerns of the people involved in activities related to the environment, the soil and the agriculture as a whole. Thus, it is understood that it was through searches for improvements in production and better quality in the final product for their consumption that people began to practice agricultural activity sustainably (BRASILEIRO, 2009).

Agroecology is, therefore, the result of the evolution of agricultural practices developed through observations and researches of all those involved in agricultural activities in search of more sustainable production. However, it is essential to clarify that some authors do not consider agroecology a science because it gathers the knowledge of common sense that, by definition, is not scientific. Thus, it is possible to understand that the explanations about the concept of agroecology are not yet very well determined since there is disagreement between the opinions of some authors (SANTOS *et al.*, 2014).

Feiden (2005) explains that:

(...) agroecology is science under construction, with transdisciplinary characteristics integrating the knowledge of several other sciences and including, traditional culture, but this is validated employing scientific methodologies (even though sometimes it is non-conventional methods).

Agroecology is also considered alternative agriculture because this term is used to define a means of production in which the environment and the soil are not harmed, thus maintaining the health of producers and consumers. At this point, it is indispensable to mention that over the years, different segments emerged for this practice. They are organic farming, biology, natural, biodynamic, and permaculture (FINATTO; SALAMONI, 2008).

- *Organic agriculture*: It is a productive process wrapped with the consistency and sanity of the culture of live food to ensure the health of human beings, for this reason, uses and develops technologies corresponding to the local reality of soil, climate, water, topography, radiations, and biodiversity of each context;

- *Biological agriculture*: It is a mode of cultivation that aims to produce high-quality food and textile fibers while

promoting sustainable and positive impact techniques in the agricultural ecosystem;

- *Natural agriculture* was developed by Mokiti Okada (1882-1955), this method recommends natural cultivation where there is the harmony of the environment, with food, with the health of man, and with spirituality;
- *Biodynamic agriculture*: It is very similar to organic agriculture, treats soil fertility, plant growth and livestock care as ecologically interrelated tasks highlighting the spiritual and mystical perspectives;
- *Permaculture*: A culture that encompasses holistic methods to plan, update, and maintain human scale systems (gardens, villages, and communities) environmentally sustainable, socially fair, and financially viable.

In Brazil, the concept of agroecology emerged through the creation of non-governmental organizations (NGOs), at the beginning of the years 1980. Today, this concept is present in all regions of the country, mainly amongst small communities and settlements, in addition to involving a considerable amount of scientists, academics and scholars from various areas (NODARI; GUERRA, 2015). In regions such as Rio Grande do Sul, Santa Catarina, and São Paulo it has already been implemented agroecological techniques in the crops. From the information provided by the national policy of technical assistance and agricultural extension, an expansion of agroecological activities that occur thanks to the organized extension practices. These activities obtained a considerable increase in Brazilian soil (NOTAROBERTO *et al.*, 2017).

In most Brazilian states, there are already programs focused on agroecology, quality of life, and conservation of the environment (AZEVEDO; PELICIONI, 2011).

IV. INTRODUCTION OF AGROECOLOGY IN NORTHEAST SEMI-ARID

The Brazilian semiarid has many chances of becoming a significant producer of organic foods. This region covers an area of 975,000 sq.km, formed by ten federative states. Formerly the semiarid was seen as an unproductive field. However, this time has remained in the past; today, the producers claim that the land is fertile and productive. Thus, non-governmental organizations want to disseminate agroecology to the individual farmer, with greater precision in the communities of family farmers (MAZZOLENI; NOGUEIRA, 2006).

The northeastern region of Brazil, particularly the region corresponding to the semiarid, has been seen over the years as a "problem region", in which the different and recurrent forms of state intervention did not obtain

the expected results, in relation to social issues and their resolutions: expressive income inequality, poor living conditions, low levels of employment and income, among others, which mainly affect the rural population.

We observed several experiences in the semiarid, through communities that seek a means of producing healthy foods, through practices with agroecological principles. In this sense, Silveira (2002) argues that: Overcoming the problems experienced by family farming in regions with water scarcity requires the incorporation of innovations related to agricultural management, which allow achieving a growing balance between the intensification of space use and the regeneration capacity of biophysical conditions that subside the fertility of agroecosystems.

When observing the approaches superficially concerning the agricultural cultivation in the semiarid region of the Northeast, social representations most often appear associated with a hostile and inadequate landscape for any productive activity. However, when considering this environment in a more attentive way, despite the climatic seasonality existing in the eco-regions, there is a broad biological potentiality of agro-ecosystems that are composed in the caatinga biome (VIEIRA-FILHO *et al.*, 2016).

Concerning the context of these semiarid regions, it is indispensable to mention that the primary source of water is from rains, these, in turn, are scarce and irregular. This way, Curado, and collaborators report (2014): In this brief characterization of the semiarid region and adjacencies, it can be affirmed that its primary input is rainwater. These rains are distributed in an irregular uncertain way. However, families depend on regularity in the satisfaction of a series of water demands for human consumption, domestic, for supply to animals and agriculture.

In the semiarid regions with the most significant number of inhabitants, addressing the problems of access to water resources is essential to overcoming obstacles to development. Thus, public policies need to be established to insert appropriate infrastructure to provide adequate water to ensure the animal and human supply, besides assisting in irrigation (SILVA *et al.*, 2016).

In this way, public policies work in two ways: building large reservoirs (in this case the dams) with a capacity of billions of cubic meters, which are found in small quantities in some states; and with small reservoirs of capacity of thousands of cubic meters, these being found in the whole region. We can still highlight the cisterns and wells, which also work like other forms of water storage in the rural environment (ASSUNÇÃO;

LIVINGSTONE, 1993). This number of reservoirs has been growing thanks to the efforts of municipalities and communities in general, but compared to rural needs, this number is still insufficient to meet all local requirements. In this sense, Silva (2007) explains that:

One of the great misconceptions of the actions of “combating drought” by Governments relates to their fragmented and reductionist vision that identifies the lack of water as the main problem to face. Thus, it refers to the need for a new reading that brings the hinterland man closer to nature, with a holistic and ecological approach, perceiving this interrelationship as a fundamental element in the social and cultural processes in the semiarid region. Still, in this line of Reasoning, Silva (2007) mentions that:

Articulated to the emergence of a new sustainability paradigm, there are changes in the conceptions and perspectives of intervention in the Brazilian Semiarid, as space where it is possible to construct or rescue relations of coexistence based on sustainability quality of life of the country's families and encouraging appropriate economic activities. The protagonist in the affirmation of this new paradigm does not belong to Governments or dominant regional groups. The original formulators of the proposal of coexistence are civil society organizations and some public agencies of research and extension that work in the semiarid. These actors have been putting the challenge of influencing and disputing the processes of formulating public policies in the region.

Besides, this semiarid vegetation requires a brief analysis of the predominant factors of this caatinga landscape. In turn is a biome with high biodiversity, in which it stands out the plant formation xerophytes, with small leaves that decrease the transpiration with moist stems to store water and roots scattered to capture the maximum water in the period of rains (Tróleis, Santos, 2011). In addition to cacti, arboreal, herbaceous and shrubby species stand out, some of which are endemic. With the arrival of the first rains, the Caatinga loses its dry appearance giving way to a green and flowered landscape. This phenomenon serves as an inspiration for the most diverse manifestations of northeastern culture (BRASIL, 2009).

For example, the poet Patativa do Assaré in his work “A Festa da Natureza” cites: “Arriving the time of winter everything is loving and tender, meaning the eternal father his infinite goodness. Our beloved, burninated naked, is soon transformed into the most beautiful garden.”

However, the Brazilian semiarid has very complex characteristics, both with human occupation and

geophysical aspects, the deceive of its natural resources and even concerning the climate, which is shown with significant differences. In this context, Ab'Sáber (2003) highlights that:

At the beginning of the decade of 1970, the existence of four regional bands within the semiarid: the semiarid bands accentuated or sub-desert (known as “wild hinterland”); the typical semiarid or semiarid bands (the “High Hinterlands”); Moderate semiarid bands (harshly caatingas); and the transitional subareas or subsumed tracks (the harsh lands).

Due to the lack of knowledge of such particularities of this vegetation, agricultural practices lead to degradation causing environmental inequity. In this context, studies conducted by the Ministry of Environment indicate that 68% of the caatinga biome area is anthropic, being 35.3% extremely anthropized (SILVA, 2003). The zoning carried out by the Brazilian Agro-livestock Company (EMBRAPA), of 1993, revealed that the semiarid, about 16 million hectares (16% of the total) with good agricultural potential, 43 million hectares (44%) with limited agricultural potential but likely to be exploited under certain conditions, and about 35 million hectares (36%) with substantial restrictions on agrarian use (VAINER *et al.*, 2002).

To achieve success with this agroecological cultivation, it is necessary to have several cares, the main of which is the zeal with the soil, its recovery, and the maintenance of its natural equilibrium. According to Almeida (1998):

(...) we need to develop and apply creative solutions to minimize the use of industrialized inputs and maximize the use of natural resources, based on the concern with erosion control and the conservation of fertility and biota of the soil/plant system.

The soil is being recognized as a living entity, where the beings present not only depend on physical or chemical conditions, besides interfering with their large scale of practices (ARAÚJO, 2002). The Northeastern family farming is marked by its significant problems, among them the scarcity of rains. Despite these problems, the region is responsible for 55% of the Brazilian family agricultural production. Another issue of great importance in this region is related to the farm production methods and the consequent losses of the soil (CASTRO, 2012), as stated by Sousa (2007):

The lands are getting weaker and weaker because of the off-farm. The deforestation, the “drill,” the fires, the planting hill below, the monoculture and the use of poisons, cause erosion, spoil the land and decrease production, year by year, besides contributing to the

process of desertification of some areas in the region.

Procedures that reduce unexpected losses by water flow in the soil can benefit the penetration of water on the ground. Thus, it can be ensured the supply of water for the cultivation of grains, prevents erosion, and prevents flooding and the obstruction of rivers. At the same time are supplied the groundwater that nourishes the water flows. If during the rainy season, the terrain is not cultivated or graded there may be destruction and damage to the soil as well as the loss of water. Traditional methods of soil preparation, such as sowing in pits, are inefficient to repress the physical deterioration of the terrain (SANTOS; GRIEBELER; OLIVEIRA, 2010).

EMBRAPA researchers evaluated some soil tillage techniques. Among these, the best result obtained was the procedure known as barred grooves. The use of this method provides greater efficiency in the cultivation of grains and the structuring of the terrain (SANTIAGO; ROSSETTO, 2019).

In these agricultural precepts, soil biota is influenced a lot by the activities employed. For example, fertilization, crop rotation, irrigation, and land tillage systems and vegetation protection. However, this same biota manages processes such as mineralization, humidification, decomposition, immobilization and mobilization of micronutrients and macronutrients, aggregation and structuring of soil, nitrogen fixation and regulation of pests (COLOZZI FILHO, *et al.*, 2016).

According to Doran and Parkin (1994):

(...) soil quality is the capacity it has to exert its function within an ecosystem, namely: sustaining biological productivity; mitigate the effects of damage on the environment and promote animal and plant health.

In this field of activity, research is evolving and seeking to incorporate sustainability in agricultural production with the help of rural communities. Currently, even more plants that are resistant are developed in Brazilian environments and climates, in this case, the semiarid, in which some plantations may develop with low water consumption; seeds are produced for small cost systems in which fewer chemical fertilizers and pesticides are used for pest control. Included in this with higher productivity, the generated income also grows; these are tactics for conservation and application of our natural and social capital (SAMBUICHI *et al.*, 2012). For a better understanding of the terms used according to the Glossary of Culture (2007) “*The natural capital is constituted by the appropriation of natural resources that owns a region, and the share capital represents the degree of trust between the actors of a society, or positive attitudes towards civic behavior that contribute to the general*

well-being.”

In the hinterland, the agricultural economy is marked by pastoral activities, the creation of livestock and goats and sheep, and other species resistant to drought in the drier areas. This includes cotton and carnauba wax, and the production of maize, beans and manioc in the moistest regions and the sugarcane that is widely cultivated in the swamps of elevation (CARVALHO, 1993).

It is of utmost importance to give special attention to the vegetal extractivist field. Since the semiarid presents a great richness of plants resistant to the dry climate that could be exploited in the economic sphere. As for examples: oil producers (catolé, faveira, quince and oiticica); waxes (carnaúba); fibers (BROMELIACEAE); latex (pinion, maniçoba); fruit trees (imbuzeiro); medicinal trees (babosa, juazeiro) and general forage (some species of grass) (DUQUE, 2004).

The northeastern hinterlands present a massive amount of plants, but the knowledge about these is quite scarce. In this way, the preservation of the caatinga and the forest management, to keep these species in the environment, so that, subsequently, the population can use these plants, are means that need to be traversed so that it can reestablish this coverage vegetable. In this sense, government actions are essential (SANTOS; CAMERA, 2002).

Concerning reforestation, with exotic plants, further studies are needed to ensure more excellent safety when inserting them into the northeastern semiarid region. As an example, it is possible to cite the micro-region of the hinterland of Moxotó (formed by the municipalities of Pernambuco: Arcoverde, Betânia, Custodia, Ibibirim, Inajá, Manari and Sertania), where reforestation activities with eucalyptus are already observed, with results harmful to the soil (CALDAS *et al.*, 2015).

The breeding crop is probably the most important of the options for the caatinga, primarily because it engages a region with a scarcity of protein. Successful actions in the municipality of Taperoá, district of Cariri in the state of Paraíba, have evidenced that the plantation of palm and the haymaking of forage resistant to drought, such as Buffel grass and uroclou, incorporated to the creation of a similarly resistant and double cattle ability (meat and dairy products), have allowed the survival of man in the region. Fish farming is another option that can be accomplished by using the capacity of existing dams (SOUZA *et al.*, 2019).

It is also of paramount importance to supply food for animals during periods of drought. Thus, it is an indispensable policy of supply of sugarcane bagasse, from sugar mills located in moist regions of the Northeast, to

be hydrolyzed and offered to animals (SOUZA *et al.*, 2019).

A more refined look is essential concerning the cultivation of grains in the boundaries of the semiarid. Since the climate of the region is severely unstable, making grain production a real “lottery.” In this way, the northeastern man is exposed to vexing situations of plowing the soil, planting the seeds and then seeing the production ruin itself with the merciless drought (SARTORI *et al.*, 2016).

After evaluating the individualities of the semiarid, it is possible to identify the causes and effects related to traditional agricultural production; thus, it is necessary to analyze the potential changes in this mode of production, so that there is a subsequent modification of the same. Here, it is crucial to cite how the agroecological sustainable output is given, because this way one can redefine the best methods to be used in planting, as well as in the cattle culture, among others (VIEIRA FILHO; SILVEIRA, 2012).

Agroecological practices seek to establish new formats of relationships between society and nature; since this is an environmentally appropriate, socially fair and economically viable practice. According to Santos and his collaborators (2014), this agriculture encompasses several production methods, amongst them:

Intercropping – a technological option for the small rural producer, since the second cultivation becomes a new source of income, strengthening the financial stability of the farmer, and influences to increase the productivity of the crop and decrease the number of pesticides;

Selective weeding – consists of selectively extracting herbs that have been maturing and which have been physiologically rebounded by cultivated plants;

Crop Consortium – Is an agricultural conservation technique that tends to better use in the long term of the soil. It focuses on planting different species close to each other;

Level Curve – it is the name used to indicate an imaginary line that groups two points with the same altitude. Through it is made the topographic maps, because, from the observation, the technician can decode their information through a three-dimensional view of the relief;

Dead coverage – it is one of the most beneficial practices that an owner can use to improve the health of their trees. Dead roofs are materials placed on the surface of the soil to maintain moisture and improve its conditions;

Organic fertilization – fertilizers obtained utilizing vegetable or animal origin, such as manure, flour, bagels, husks and remnants of plants, decomposed, or still in the

decomposition stage. These materials are decomposing and can be produced by man through composting;

Green fertilization (or green planting) – it is the name given to the practice of adding leguminous plants on the soil surface to enrich it nutritionally with nitrogen. The increase in the presence of nitrogen in the soil favors the improvement of plant biomass production;

Crop rotation – it consists of alternating, annually, plant species in the same agricultural area. The species chosen must have, at the same time, commercial and soil recovery purposes;

Natural insecticides – natural products derived from plants can be an alternative to pest control;

Reforestation – it is an environmental action that aims to repopulate areas that have had the vegetation removed by the forces of nature (fires, for example) or human activities (burned, wood exploration, expansion of agricultural areas, fires)

Agroecology has been gaining space in all Brazilian socioeconomic aspects, as well as in academic spaces, permeating the political-ideological discussions about sustainable agriculture (NODARI, 2015). As Fávero and Pacheco stress (2013):

Agroecology has been rooted in all Brazilian socioeconomic environments and contexts with a functional diversity of expressions, perceptions, and perspectives; it has increasingly permeated the scientific-academic circuits and, at the same time, is putting firmly into the political-ideological clash as a sustainable option of life in the field. It materializes, therefore, as a movement, carried out by a wide range of social organizations and networks; as a science, which is being constructed from conceptions, principles and methods differentiated from the Cartesian-positivist precepts; and as a practice experienced, transmitted, innovated and (re)invented by farmers and agriculture in different conditions and realities throughout the Brazilian territory using this denomination or not.

Because of the above, we perceive the evolution of agroecology over the years in Brazil, especially in the semiarid region of the Northeast. Interestingly, agroecology has been expanding in several areas, such as socioeconomic and academic spaces. What is new and particularly relevant to this study are the agroecological techniques used in the territory of Exu-PE, our question is whether these techniques are being worked in appropriate ways, whether there has been changing or just an exchange of methods of production.

V. AGROECOLOGY IN THE MUNICIPALITY OF EXU-PE

The Araripe region, in which the municipality of Exu is located, concentrates 40% of the world gypsum reserves and is therefore characterized by the exploration of the mineral in the so-called gypsum-polo. The mineral reserves are one of the significant differentials of the region, is estimated at 1.2 billion tons. Gypsum extraction represents 95% of the national gypsum production, which enabled the formation of an industrial park in the region, generating about 12,000 direct and 60,000 indirect jobs (IBGE, 2010).

Besides the extraction of gypsum, which is the main activity, there is the subsistence culture in the upland areas; the large livestock and the diversified agriculture in the Chapada (plateau) do Araripe (SILVA *et al.*, 2006).

Exu is part of the Araripe development region, located in the hinterlands of the state of Pernambuco mesoregion. It represents 18.8% of the state territory with 18,576.9 sq.km and covers the municipalities of Araripina, Bodocó, Cedro, Granito, Ipubi, Moreilândia, Ouricuri, Parnamirim, Salgueiro, Santa Cruz, Santa Filomena, Serrita, Trindade and Verdejante. The municipality of Exu is mainly inserted in the Geoenvironmental unit of the Maciços and Serra Baixas, with altitudes between 300 and 800 meters. To the north, a portion is embedded in the Geoenvironmental group of the high plateaus (IBGE, 2010).

Exu is a municipality in the state of Pernambuco, in the Brazilian outback. Administratively, the city is composed of the headquarters district and the villages of Tabocas, Timorante, Viração, and Zé Gomes. Located on the BR-122, the height of the Serra do Araripe is the last city in the border between the states of Pernambuco and Ceará. With its 109 years, it has been growing gradually. The region where the municipality is located was initially inhabited by the Ançus Indians, from the Cariris' trunk. The area was occupied by cattle farms in the early 18th Century, with Leonel de Alencar Rego and subsequently his son, Joaquim Pereira de Alencar. After the occupation, Jesuit missions lived in the region, where they built the chapel of Bom Jesus dos Aflitos (IBGE, 2010).

The municipality was installed on June 7, 1885, gaining autonomy on July 9, 1893, due to Law # 52, of August 3, 1892. The first mayor was Manoel da Silva Parente. The municipality was suppressed in 1895 and restored 1907, with the designation of Novo Exu. By state Decree-Law # 235, of December 9, 1938, the city of Novo Exu became the denominate Exu (IBGE, 2010).

The city is located in the polygon of drought; its

relief presents flat and rugged terrains influenced by the Chapada (plateau) do Araripe, with highlands, flat and descending the mountains, are low lands, fertile land, and several springs at the foot of the hill. The vegetation is predominantly of deciduous forest and hypoxerophyll caatinga. The municipality also has the plant of the savanna at the foot of the plateau, with species such as aroeira, braúna, sabiá, plum, pequi, sucupira, angico, white and red amburana, cedar, angico, eucalyptus, and the barriguda, almost extinct (SILVA *et al.*, 2006).

Yres explains (2014):

Among the vegetation types in the semiarid region is the Cerrado, whose flora represents the continuity of the flora present in Central Brazil. The Cerrado has two distinct seasons: dry winter and rainy summer. With tropical savannah soil, nutrient deficient and rich in iron and aluminum, it houses dry-looking plants, between sparse shrubs and grasses, and Cerradão, a denser type of vegetation, of forest formation, formed by low and twisted trees highlighted in the middle of the greens covering the top of the plateaus.

The main animal species of the region are the preá, tatupeba, opossum, sagui, vulture, owl, hawk, fox, as well as a large variety of birds and reptiles. The municipality of Exu is located in the watershed of the Brígida River. Its main tributaries are the streams of Brígida, Carnaúba or Carrancudo, Queimada Grande, Tabuleiro, Cantarino, do Ouro, California, Manicoba, Zé Gomes, Estrada, Paus Grandes, Tabocas, Mocambo, São Joaquim, and Tigre, all of which are intermittent. It also has the lagoons of Caraíba, de Dentro, Cascavel, Caracol, Grande, and Marrecas (SILVA *et al.*, 2006).

The city of Exu has the predominant economic activity of agriculture. Cattle and swineherds are in more significant numbers. The main cultivated agricultural products are beans, tobacco, corn, cassava, coffee, and castor bean. The agrarian practice in Exu gives itself, in its vast majority, in a traditional way; from soil preparation to harvesting. The soil is prepared by burning after the first rains expect the process for planting the seeds. In this period, farmers expect the rainy season to thrive for the plantation to be harvested; the harvest is done manually.

In the municipality, there are already some communities that practice agroecology. Among them are the Baixio do Meio, the Serra do Ingá and Serra da Refrigerera with a production, mainly of fruit and vegetable trees; the most prominent community is ruled by the Lermen family, in the Serra dos Paus Doíás site.

VI INFLUENCE OF CIVIL SOCIETY ORGANIZATIONS IN THE IMPLEMENTATION OF AGROECOLOGICAL SYSTEMS IN EXU-PE

The NGO Caatinga (Center for Advisory and Support to Workers and Alternate Non-Governmental Organizations) has been working for more than 25 years with agricultural families in rural communities in the territory of Sertão do Araripe, in the State of Pernambuco.

Indirectly, its performance extends to the entire semiarid through its participation in the Network of Technical Assistance and Rural Extension of the Northeast (Ater-NE network), the Articulation of the Brazilian Semiarid (ASA) and the National Articulation of Agroecology (ANA).

About the NGO, Carvalho argues that:

Since its inception, the entity has maintained its firm purpose to support the construction of knowledge, technologies, and practices of agroecological basis together with agricultural families and their organizations, as a way to strengthen the capacity of rural populations for dignified and sustainable coexistence with semiaridity. (2007)

In 2006, the CAATINGA acquired the position of national Focal Point of Civil Society of the United Nations Convention on Combating Desertification (UNCCD), a political representation attributed and backed by ASA.

Several families and rural communities have changed their lives through the most harmonious relationships with nature. His experiences prove that environmental degradation is not an irreversible result of family farming in the semiarid. Accordingly, Carvalho (2007) states that: People do not degrade because they want to. On the contrary: many public policies and market agents continue to be encouraged to adopt degrading practices that put them in a situation of a significant vulnerability in the context of drought risk. Besides, most families have not yet had the opportunity to develop innovative initiatives based on the principle of coexistence with the semiarid in their properties.

The experiments developed in the Araripe region indicate that there is a broad “sensitivity and receptivity” to the new management approaches based on the principles of agroecology. However, many limitations hinder the generalization of these techniques. The local novelty is a necessary condition for these techniques to progress and adapt to the particularities of each family and community. It requires “mobilization and social organization” to create adequate spaces for the cultivation and socialization of agroecological knowledge. This

mobilization is essential to influence public managers and public policy formulators. Thus, it is indispensable that the struggle for the stabilization of sustainable development is constant, building knowledge in a dialogical way and committed to a “fair society, economically viable, environmentally balanced and fraternal” (TEIXEIRA PIRES, 2017).

By extending the positive influences of the experiments that already exist in coexistence with the semiarid, it can be ensured that the environmentally sustainable and socially inclusive development is probably in the region. However, Carvalho (2007) clarifies that:

(...) it is necessary to involve more people, organizations, and networks of civil society to maintain and broaden the dynamics of the construction of agroecological knowledge, mobilizing and gathering forces to achieve the stable and concrete changes in the policies of State and finally in the rural development model in the region.

The caatinga has offered its support in this procedure, acting as an organization encouraging the building of new knowledge alongside communities, agricultural families, networks and articulations, as well as encouraging the spaces for the elaboration of public policies with the help of social organizations and movements (SANTOS; SILVA, 2015; SANTOS; SILVA, 2016; SOARES et al, 2018;.

The Center for Enabling and Supporting the Small Farmer of Araripe (CHAPADA in Portuguese), was created in April 1994, by a group of farmers/the family and technicians of the municipality of Araripina, Sertão de Pernambuco.

The work of CHAPADA is developed in ten municipalities of the Araripe region in the state of Pernambuco, in addition to six towns in the area of the middle São Francisco in the state. The actions of the entity are geared towards farmers and family farms organized in associations, cooperatives, unions, and forums. This work is supported by the Association of the One Million Cisterns Program (APIMC); Ministry of Agrarian Development (MDA); Secretariat of Family Agriculture (SAF); Secretariat for Territorial Development (SDT); Project Dom Helder Câmara (PDHC); International Service/European Union; Secretariat of Agriculture and Agrarian Reform (SARA) and Pro Rural.

The activities developed to allow the recovery of soils and native vegetation, as well as enable the implantation of agroecological systems, and the development of the production chains of manioc-cultivation, horticulture, beekeeping, and caprino-ovino-

culture. From this, the institution implements actions to create a good water infrastructure in rural communities, especially concerning access to water for human consumption, domestic, water supply for animals and other productive purposes.

It is in the perspective of guaranteeing food security and the generation of work and income for agricultural families, which gives access to markets for commercialization of agroecological products *in natura* as well as processed ones. The CHAPADA promotes educational actions that strengthen the organizations represented by farmers/family members, intending to facilitate access to public resources, and in defense of social rights, contributing to the realization of citizenship.

The institution discusses and considers in all its projects, gender relations from the perspective of differences and inequalities existing between men and women. The idea is to build an alternative path to promote equal opportunities. Currently, in all its activities, the CHAPADA has privileged and stimulated the presence of young people.

The mission of the institution as mentioned earlier is to strengthen the socioeconomic, political and cultural development of family farming, through the recovery and preservation of the environment, through agroecology and the realization of citizenship in the semi-arid. The objectives of the NGO are:

Provide professional training, advice, and technical assistance to farmers/family members, enabling food security, generation of employment and income with environmental and social sustainability of the estates.

Offer professional training, advice and technical assistance to the processing units of agricultural products, seeking the quality of processed products;

Offer professional and business training to farmers/family members, stimulating the associative organization ensuring access to markets. In particular, concerning the organization of agroecological fairs and access to government marketing programs;

Develop actions to create a water infrastructure in rural properties and communities;

Develop measures that facilitate the access of farmers to public policies for the development of family farming and the improvement of quality of life in rural communities;

Promote educational activities that strengthen associative political articulation, in a way that assures the conquest of social rights and citizenship;

Develop actions that contribute to gender equality and the promotion of youth rights.

The NGO participates in the following institutional

spaces: articulation in the Brazilian semi-arid (ASA Brazil); Sustainable Development Council of Pernambuco (CDSPE); Araripina Rural Development Council (CDRA); State Environmental Council (CONSEMA); Municipal Council for Social Action of Araripina; Municipal Council for Rural Development of Araripina (CMDR); Municipal Council for Sustainable Development of Ipubi (CONDESI); Araripina Municipal Environmental Council (CONDEMA); Municipal Council for Food Security and Sustainable Nutrition of Araripina (COMSEA); Forum of the Goat and Sheep Breeding in the Araripe region; Manioc-Culture Forum of the area of Araripe in the state of Pernambuco (FOMAPE); Araripe Women's Forum; Territorial Forum of Araripe (FOTEAR); Pact of beekeeping of the Sertão do Araripe (Forum Pasa).

The CHAPADA is affiliated with the Brazilian Association of Non-Governmental Organizations (Abong). The NGO directs its action, from four strategic axes that enable the fulfillment of its mission. They are:

Agroecology and coexistence with semi-arid – guiding activities aimed at the implementation and development of agroforestry systems, organic horticulture, honey production, goat and sheep breeding, poultry farming, fish farming, enlargement and adequate management of hydric infrastructure of rural properties and communities;

Entrepreneurship in family farming and access to markets – agriculturists and family farmers qualified in property planning, cost calculations and sales price, and rural entrepreneurship. Technical monitoring in the implementation and development of agroecological municipal fairs, local fairs of goats and sheep and sales to commercial establishments;

Youth Protagonism – stimulating actions that contribute to the professional qualification and insertion of young people in agroecological farming activities, as a fundamental strategy for the generation of income and fixation of young people in rural areas. Youth Protagonism is stimulated from community activities and local development;

Communication and institutional strengthening – expansion of social visibility through institutional actions, in the perspective of strengthening and disseminating the results achieved with the agricultural families and their organizations involved in the work of Entity.

The CHAPADA strengthens the socioeconomic, political and cultural development of family farming, through agroecology and the realization of citizenship in the Brazilian semi-arid. The city of Exu is part of the organization's territory and has significant results in the

field of sustainable family farming and coexistence with the semi-arid.

VII CONCLUSION

The primary purpose of this work was to describe the agroecology, its methods and utilization, verifying the implantation of the same in the municipality of Exu-PE, more precisely in the Chapada (plateau) do Araripe in the Serra (Mountain) dos Paus Doíás. Agroecology is providing scientific and methodological bases for the production of various types of sustainable agriculture, having as one of its main objectives the need for food production in larger quantities and high quality biologically for the whole of society.

From the study, we also understand that agroecology brings with it its characteristics enabling a more precise understanding regarding the life of the family producer who inhabits the municipality of Exu-PE. The results of this work help to conceive the importance of agroecology, highlighting its fundamental social role of the inequality of the countryside and cities, this sector must be regarded as a strong element of wealth generation for the economy, not only for the agricultural sector or even for a specific region, but also for the whole country. Thus, we believe that agroecology fulfills a significant social, cultural, and economic role, also guaranteeing food safety for consumers of food produced under this method.

REFERENCES

- [1] AB'SABER, A. (2003). Os Domínios de natureza no Brasil: Potencialidades Paisagísticas, São Paulo: Ateliê Editorial,
- [2] ALMEIDA, D. L. (1998). Sistema Integrado de Produção Agroecológica ("Fazendinha Agroecológica km 47"). In: ENCONTRO NACIONAL SOBRE PRODUÇÃO ORGÂNICA DE HORTALIÇAS. 1998, Vitória. Anais... Vitória: EMCAPA.
- [3] AQUINO, A. M.; ASSIS, R. L. (OrgS.) (2005). Agroecologia: princípios e técnicas para uma agricultura orgânica sustentável – Brasília, DF: Embrapa Informação Tecnológica.
- [4] ARAÚJO, Q. R. (org.). (2002). 500 anos de uso do solo no Brasil. Ilhéus, Ba: Editus.
- [5] ASSIS, R. L. (2006). Desenvolvimento rural sustentável no Brasil: perspectivas a partir da integração de ações públicas e privadas com base na agroecologia. Econ. Apl., Ribeirão Preto, v. 10, n. 1, p. 75-89. Available from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1413-80502006000100005&lng=en&nrm=iso. Access on 20 may 2019. <http://dx.doi.org/10.1590/S1413-80502006000100005>.
- [6] ASSIS, R. L. (2005). Agricultura orgânica e agroecologia: questões conceituais e processo de conversão. Seropédica: Embrapa Agrobiologia. (Embrapa Agrobiologia. Documentos, 196)
- [7] ASSUNÇÃO, M.; LIVINGSTONE, I. (1993). Desenvolvimento inadequado: construção de açudes e secas no sertão do Nordeste. Bras. Beon. Rio de Janeiro, v. 47, n. 3, p. 425-48.
- [8] AZEVEDO, E.; PELICIONI, M. C. F. (2011). Promoção da Saúde, Sustentabilidade e Agroecologia: uma discussão intersetorial. Saude soc., São Paulo , v. 20, n. 3, p. 715-729. Available from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0104-12902011000300016&lng=en&nrm=iso. Access on 20 may 2019. <http://dx.doi.org/10.1590/S0104-12902011000300016>.
- [9] BRASILEIRO, R. S. (2009). Agricultura de base agroecológica como viabilidade para o desenvolvimento rural sustentável: o processo de organização de agricultores familiares para o desenvolvimento de cultivos dentro dos princípios agroecológicos. Revista de Geografia. Recife: UFPE – DCG/NAPA, v. 26, n. 3.
- [10] CALDAS, R. M. S.; MACHADO, J. ANDRADE, J. S. C. O.; WANDERLEY, R. A. (2015). Processing of Melon crops for beekeeping in the backwoods of Moxotó represented by Digital Terrain Model. Revista GEAMA, Recife, v. 1, n.1.
- [11] CAPORAL, F. R. (2007). Extensão Rural e Agroecologia: temas sobre um novo desenvolvimento rural, necessário e possível. Brasília: MDA.
- [12] CAPORAL, F. R. COSTABEBER, J. A. (2004). Agroecologia: alguns conceitos e princípios. Brasília: MDA/SAF/DATER-IICA.
- [13] CARVALHO, P. P. A (2012). convivência com o semiárido como estratégia para o combate à desertificação: Uma experiência no Sertão do Araripe. Agriculturas | v. 9 - n. 3 | dezembro de Available at: <http://www.agriculturesnetwork.org/magazines/brazil/desertificacao/experiencia-sertao-doararipe#sthash.7qUoQxmi.dpuf>. Access on April 24th, 2019.
- [14] CASCÃO, R. *et al.*, (coords). (2007). Glossário de Cultura. Serviço Social da Indústria. Departamento Nacional. SESI. DN. Brasília: SESI/DN. Available at: http://www.sesipr.org.br/uploadAddress/Glossario_de_Cultural130431.pdf Access on April 15, 2019.
- [15] CASTRO, C. N. (2012). A agricultura no Nordeste brasileiro: oportunidades e limitações ao desenvolvimento. Texto para discussão. Instituto de Pesquisa Econômica Aplicada. Brasília: Rio de Janeiro: Ipea.
- [16] COLOZZI FILHO, A. *et al.* (2016). Reunião Brasileira de Manejo e Conservação do Solo e da Água (20: 2016: Foz do Iguaçu, PR) Anais da XX Reunião Brasileira de Manejo e Conservação do Solo e da Água [electronic book]. Curitiba: SBCS/ NEPAR; Londrina: IAPAR.
- [17] CURADO, F. F. *et al.* (2014). Sistematização de Experiências Agroecológicas no Território Semiárido Nordeste II, Bahia. Cadernos de Ciência & Tecnologia, Brasília, v. 31, n. 2, p. 349-380.
- [18] D'ÁVILA, D. (2004). Cuidado sistematizado ao paciente

- com monitorização da pressão intracraniana: Uma Proposta. Palhoça: Monografia de especialização de Enfermagem em Emergência e Terapia Intensiva, Universidade do Sul de Santa Catarina.
- [19] DE DEUS, R. M.; BAKONYI, S. M. C. (2012). O impacto da agricultura sobre o meio ambiente. *Rev. Elet. em Gestão, Educação e Tecnologia Ambiental* v. 7, nº 7, p. 1306-1315.
- [20] DORAN, J. W; PARKIN, T.B. (1994). Defining and assessing soil quality. In. Doran, J. W. *et al.* (Eds.) *Defining soil quality for a sustainable environment*. Madison. ASA/SSSA.
- [21] DUQUE, J. G. O (2004). Nordeste e as lavouras xerófilas 4a ed. Fortaleza: Banco do Nordeste do Brasil.
- [22] FÁVERO, C.; PACHECO, M. E. L. (2013). Agroecologia: princípios e reflexões conceituais: Seguindo em frente na construção social da agroecologia. GOMES, J. C. C.; ASSIS, W. S. (Org.); Brasília, DF: Embrapa.
- [23] FERREIRA, A. B. H. (2001). *Minidicionário Aurélio da Língua Portuguesa*. 4ed. rev. ampliada. Rio de Janeiro: Nova Fronteira.
- [24] FINATTO, R. A.; SALAMONI, G. (2008). Agricultura familiar e agroecologia: perfil da produção de base agroecológica do município de Pelotas/RS. *Sociedade & Natureza, Uberlândia*, v. 20, n. 2, p. 199-217.
- [25] FUNDAÇÃO BANCO DO BRASIL (2009). Manual de Capacitação da Tecnologia Social PAIS Produção Agroecológica Integrada e Sustentável. Brasília. Available at: https://www.fbb.org.br/data/files/18/D6/A9/1E/8266A31009818793BD983EA8/PAIS_Pr_tic_a%20da%20Agroecologia.pdf. Access on May 08, 2019.
- [26] HERNANDEZ, S. R. (2012). Metodología científica. México.
- [27] IBGE. «Área territorial oficial». Resolução da Presidência do IBGE de nº 5 (R.PR-5/02). «Estimativa da população 2015 » População estimada » Comparação entre os municípios: Pernambuco». Estimativa Populacional - 2015. Instituto Brasileiro de Geografia e Estatística (IBGE). Agosto de 2015.
- [28] MANZATTO, C. V., FREITAS JUNIOR, E.; PERES, J. R. R. (ed.). (2002). *Uso agrícola dos solos brasileiros*. Rio de Janeiro: Embrapa Solos.
- [29] MAZZOLENI, E. M.; NOGUEIRA, J. M. (2006). Agricultura orgânica: características básicas do seu produtor. *Rev. Econ. Sociol. Rural, Brasília*, v. 44, n. 2, p. 263-293. Available from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-20032006000200006&lng=en&nrm=iso. Access on May 20, 2019. <http://dx.doi.org/10.1590/S0103-20032006000200006>.
- [30] MONASTERIO, L. M.; NERI, M. C.; SOARES, S. S. D. (2014). *Brasil em desenvolvimento 2014: estado, planejamento e políticas públicas*. Brasília: Ipea.
- [31] NODARI, R. O.; GUERRA, M. P. (2015). A agroecologia: estratégias de pesquisa e valores. *Estud. av.*, São Paulo, v. 29, n. 83, p. 183-207. Available from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-40142015000100183&lng=en&nrm=iso. Access on May 20, 2019. <http://dx.doi.org/10.1590/S0103-40142015000100010>.
- [32] SAMBUICHI, R. R.; OLIVEIRA, M. A. C.; SILVA, A. P. M.; LUEDEMANN, G. A. (2012). Sustentabilidade ambiental da agropecuária brasileira: impactos, políticas públicas e desafios. Texto para discussão. Instituto de Pesquisa Econômica Aplicada. Brasília: Rio de Janeiro: Ipea.
- [33] SANTIAGO, A. D. ROSSETTO, R. (2019). *Árvore do conhecimento: Cana-de-Açúcar*. Disponível em: https://www.agencia.cnptia.embrapa.br/gestor/cana-deacucar/arvore/CONTAG01_84_22122006154841.html. Access May 20, 2019.
- [34] SANTOS, C. F. *et al.* (2014). A agroecologia como perspectiva de sustentabilidade na agricultura familiar. *Ambiente & Sociedade, São Paulo*, v. 17, n. 2, p. 33-52. Available from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1414-753X2014000200004&lng=en&nrm=iso. Access on 20 may 2019. <http://dx.doi.org/10.1590/S1414-753X2014000200004>.
- [35] SANTOS, G. G.; GRIEBELER, N. P.; OLIVEIRA, L. F. C. (2010). Chuvas intensas relacionadas à erosão hídrica. *Revista Brasileira de Engenharia Agrícola e Ambiental* v. 4, n. 2, p.115–123.
- [36] SANTOS, T. C. C.; CÂMERA, J. B. D. (2002). Programa das Nações Unidas para o Meio Ambiente.
- [37] SANTOS, C. A. B.; SILVA, A. P. M. (2015). Extratos vegetais de plantas daninhas contra o pulgão *aphis craccivora* Koch 1854, no feijão *vigna unguiculata* (L.) walp. *Revista Ibero-Americana de Ciências Ambientais, Aquidabã*, v.6, n.2, p.69-75. DOI: <http://dx.doi.org/10.6008/SPC2179-6858.2015.002.0005>
- [38] SANTOS, C. A. B.; SILVA, A. P. M. (2016). Viabilidade do uso de inseticidas botânicos extraídos de plantas exóticas. *Educação Ambiental em Ação*. Número 54, Ano XIV. Available on: <http://www.revistaea.org/artigo.php?idartigo=2241>. Access in: 23 march 2019.
- [39] SARTORI, G. M. S. *et al.* (2016). Sistemas de preparo do solo e de semeadura no rendimento de grãos de soja em área de várzea. *Cienc. Rural, Santa Maria*, v. 46, n. 3, p. 492-498. Disponível em http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-84782016000300492&lng=pt&nrm=iso. Access on May 20, 2019. Epub 30-Nov-2015. <http://dx.doi.org/10.1590/0103-8478cr20150676>.
- [40] SILVA, R. M. A (2007). Entre o combate à seca e a convivência com o Semi-Árido: políticas públicas e transição paradigmática. *Revista Econômica do Nordeste, Fortaleza*, v. 38, n. 3, p. 466-485.
- [41] SILVA, R. M. A. (2003). Entre dois paradigmas: combate à seca e convivência com o semiárido. *Sociedade e Estado, Brasília*, v. 18, n. 1/2, p. 339-360.

- [42] SILVA, J. B.; DANTAS, E. W. C.; ZANELLA, M. E.; MEIRELES, A. J. A. (orgs.). (2006). Litoral e Sertão, natureza e sociedade no nordeste brasileiro. Fortaleza: Expressão Gráfica.
- [43] SILVA, M. A. M.; FRUTUOSO, M. N. M. A.; RODRIGUES, S. S. F. B.; NOGUEIRA, R. J. M. C. (2016). Fatores socioambientais influenciados pela seca na conservação da caatinga. HOLOS, Ano 32, v. 4, p. 245-257.
- [44] SILVEIRA, L.; PETERSEN, P.; SABOURIN, E. (Org.). (2002). Agricultura familiar e agroecologia no Semi-Árido: avanços a partir do Agreste da Paraíba. Rio de Janeiro: ASPTA.
- [45] SOARES, T. N. A. et al. (2018). Insecticide Potential of Botanic Extracts Obtained from the Flora of the Brazilian North East Region. European Scientific Journal, v.14, n.18, p. 1-13. Doi: 10.19044/esj.2018.v14n18p1 URL:<http://dx.doi.org/10.19044/esj.2018.v14n18p1>. Disponível em: <http://ejournal.org/index.php/esj/article/view/10953>. Acesso em: 01 de junho de 2019.
- [46] SOUSA, J. E.; SILVA, A. F. (2007). Agricultura agroflorestal ou agrofloresta. Centro Sabiá. Recife-PE.
- [47] SOUZA, J. T. A.; NASCIMENTO, M. G. R.; FIGUEREDO, J. P.; NÁPOLES, F. A. M.; ANDRADE, F. H. A. (2019). Caracterização técnico-produtiva do sistema de cultivo de palma forrageira no Cariri paraibano. Revista de Agricultura Neotropical, v. 6, n. 2, p. 64-71.
- [48] TEIXEIRA, C. T. M.; PIRES, M. L. L. S. (2017). Análise da Relação Entre Produção Agroecológica, Resiliência e Reprodução Social da Agricultura Familiar no Sertão do Araripe. Rev. Econ. Sociol. Rural, Brasília, v. 55, n. 1, p. 47-64. Available from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-20032017000100047&lng=en&nrm=iso. Access on 20 May 2019. <http://dx.doi.org/10.1590/1234-56781806-94790550103>.
- [49] TROLEIS, A. L.; SANTOS, A. C. V. (2009). Estudos do semiárido. Natal: EDUFRN 2011 BRASIL. Departamento Nacional de Infraestrutura de Transportes. Diretoria Executiva. Instituto de Pesquisas Rodoviárias. Manual de vegetação rodoviária. Rio de Janeiro.
- [50] VIEIRA FILHO, J. E. R.; SILVEIRA, J. M. F. J. (2012). Mudança tecnológica na agricultura: uma revisão crítica da literatura e o papel das economias de aprendizado. Rev. Econ. Sociol. Rural, Brasília, v.50, n. 4, p. 721-742. Available from http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0103-20032012000400008&lng=en&nrm=iso. Access on 20 May 2019. <http://dx.doi.org/10.1590/S0103-20032012000400008>.
- [51] YRES, J. A. (2014). Biodiversidade e a Vegetação do Semiárido. Semiárido Nordestino. III Encontro Nordestino de Arborização Urbana. Available at: <https://janayresespgeo.wordpress.com/2014/07/02/a-biodiversidade-e-a-vegetacao-dosemiarido/>. Access on May 07, 2019.

Approach of Passive Filters using NSGA II in industrial installations: Part II

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Abstract— The optimization of passive filters in industrial systems has been presented by different computational methods. The objective of this paper is to develop a computational algorithm with NSGA II to select the configuration and design parameters of a set of passive filters for industrial installations. As a methodology, the optimization problem was addressed using three independent objective functions of innovative character for compensation of harmonics through passive filters as a multiobjective problem. The results were the computational solution to this problem that determines a set of Pareto optimal solutions (Frontier). In addition, the Computational tool has several new features such as: calculates the parameters that characterize the filters, but also selects the type of configuration and the number of branches of the filter in each candidate bar according to set of pre-established configurations according to PRODIST-M8 (Brazilian Standard) and IEEE 519-2014. Also determine solutions with good power quality indicators (THD, TDD and NPV) for several characteristic and non-characteristic scenarios of the system that allow to represent: daily variations of the load, and variations of system parameters and filters. It evaluates the cost of energy bills in an industrial power grid that has different operating conditions (characteristic scenarios) and evaluates the economic effect of harmonic filters as reactive power compensators.

Keywords—Quality Power, NSGA II, Passive Filters, multiobjective optimization.

I. INTRODUCTION

Modern electrical systems contain a large amount of contaminant sources or harmonic producers, where the nonlinear loads used in industry, commercial and residential installations stand out [1][2][3].

As fontes contaminantes de média e alta potência geralmente se concentram nos sistemas elétricos industriais. Entre estas se incluem conversores estáticos de potência e fimos de arco elétrico [4][5][6][7].

In commercial and residential installations, a large number of nonlinear loads of small power are employed, which due to their large number can not be neglected as a source of distortion. This is the case of home and office equipment, discharge lamps, among others.

The harmonics injected into the electrical system by nonlinear loads produce effects on the electrical power systems themselves and on the electrical loads connected to them, as well as on communications systems. [8][9][10][11].

All the effects of harmonics in power systems are harmful and among them we can mention [12][13][14][15]:

- 1) The possible existence of series and parallel resonances, which contribute to the amplification of harmonics and their effects;
- 2) Reduction of system efficiency, increasing losses in power generation, transmission and distribution systems;
- 3) The premature aging of the insulation of the components of the electrical network and, consequently, reduction of its useful life.
- 4) The malfunction of the system or any of its components.

One of the most damaging phenomena associated with the presence of harmonics is the possibility of **resonance** occurring in the electric circuit. Like most elements in power systems such as transformers, rotary machines, etc. have the inductive character, the presence of capacitor banks to compensate for the power factor or the own capacitive effect of the power lines can interact with the inductive elements of

the circuit so that at certain frequencies are equal to the equivalent inductive and capacitive reactances causing a condition of resonance in which high values of voltage and current, which affect the correct functioning of the system and can cause equipment failure [16][17][18].

Harmonic filters are active or passive devices, whose mission is to avoid harmonic circulation by the electrical power system to prevent the occurrence of harmful resonances and avoid other undesirable effects that may occur [19][20][21].

Although active filters have better performance characteristics than passive, the latter are still more used

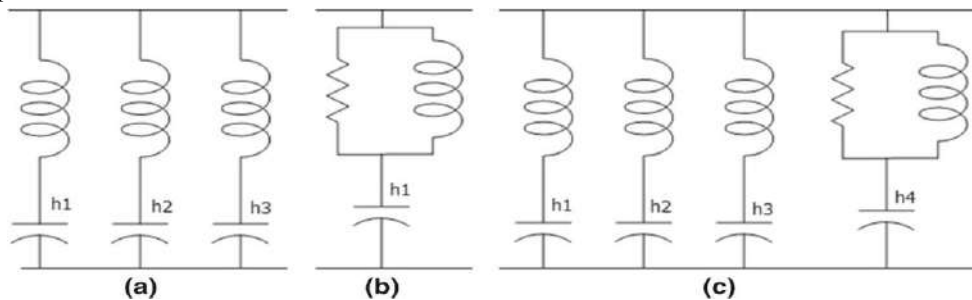


Fig.1: Predefined configurations of the filters.

Source: [23].

2.1 FILTER TYPES

A low-pass (LP) filter passes the low-frequency components and suppresses the high-frequency components. Their loss characteristic is given by

$$A(\omega) = 0, 0 \leq \omega < \omega_c \quad (1)$$

$$= \infty, \omega_c < \omega < \infty$$

The frequency from 0 to ω_c is the passband and from ω_c to ∞ is stopband. The boundary between passband and stopband $= \omega_c$ is the cutoff frequency. However, there cannot be a sudden transition from passband to stopband. Practically, passband loss is not zero, and the stopband loss is not infinite. There is a gradual transition between passband and stopband. Then, for the LP filter, the loss characteristic is [22]:

$$A(\omega) \leq A_p, 0 \leq \omega \leq \omega_p \quad (2)$$

$$\geq A_s, \omega_s \leq \omega \leq \infty$$

A high-pass filter acts in the reverse manner, suppresses the low frequency, and passes the high frequency. For an ideal filter

$$A(\omega) = \infty, 0 \leq \omega < \omega_c \quad (3)$$

$$= 0, \omega_c < \omega < \infty$$

For a practical filter, the loss characteristic is

$$A(\omega) \geq A_s, 0 \leq \omega \leq \omega_s \quad (4)$$

$$\leq A_p, \omega_p \leq \omega \leq \infty$$

than the former. Figure 1 shows the pre-definition of filters types according to [29].

II. PASSIVE FILTERS

Passive filters use passive components, such as inductors, capacitors, and resistors. These cannot increase the signal energy; the frequency range for harmonic filters is limited to approximately 3000 Hz. It is common to characterize the frequency-selective filters with respect to their passbands [22].

The bandpass filter passes frequencies within a certain band and blocks the low and high frequencies. Ideally,

$$A(\omega) = \infty, 0 \leq \omega < \omega_{c1}$$

$$= 0, \omega_{c1} < \omega < \omega_{c2} \quad (5)$$

$$= \infty, \omega_{c2} \leq \omega < \infty$$

For a practical filter, the loss characteristic is

$$A(\omega) \geq A_s, 0 \leq \omega \leq \omega_{s1}$$

$$\leq A_p, \omega_{p1} \leq \omega \leq \omega_{p2} \quad (6)$$

$$\geq A_s, \omega_{s2} \leq \omega \leq \infty$$

The loss function referred earlier can be determined as follows: A filter represented by voltage transfer function:

$$\frac{V_o(s)}{V_i(s)} = H(s) = \frac{N(s)}{D(s)} \quad (7)$$

where $V_i(s)$ and $V_o(s)$ are the input and output voltages and $N(s)$ and $D(s)$ are polynomials in s .

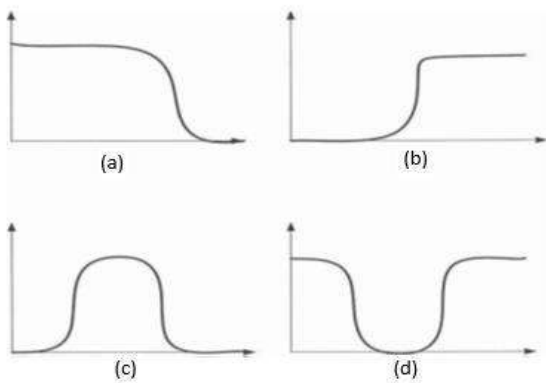


Fig.2: Frequency response of low-pass (a), high-pass (b), bandpass (c), and stopband (d) (notch) filters.

Source: [22].

The loss or attenuation is in decibels:

$$A(\omega) = 20 \log \left| \frac{V_i(j\omega)}{V_o(j\omega)} \right| = 20 \log \frac{1}{|H(j\omega)|} \quad (8)$$

The filters for harmonic mitigation are generally of shunt type to offer a low-impedance path to a certain harmonic or harmonics so that these are bypassed into the filter and their flow is minimized into the system, as discussed in the following section [22][24][25].

These may use resonance in the filter components to offer minimum impedance to a particular harmonic or a band of harmonics. This does not mean that we do not use series filters, that is, filters connected in series with the converter to impede the flow of a certain harmonic [26].

2.3 LOCATION OF HARMONIC FILTERS

Passive filters at suitable locations, preferably close to the source of harmonic generation, can be provided so that much of the harmonic currents are trapped at the source and the harmonics propagated to the point of common coupling (PCC) are reduced. Active filters, hybrid combination of active and passive filters, and phase multiplication to reduce harmonic emission. By reduction of harmonics at the source, the electrical equipment need not be oversized, losses are minimized, voltage distortions are reduced, the filters can be [22]. Conversely, when filters are located away from the harmonic producing loads, the harmonics must flow to the filter through system impedances with the resultant derating of electrical equipment. Yet, it may not be practical or economical to provide filters at each source of harmonic emission.

The key considerations are the following:

- Harmonic limitations at PCC must meet IEEE 519 requirements, but it is desirable to limit harmonic distortions throughout the power systems [22].

- Reactive power compensation may be simultaneously required.
- Normal and contingency conditions of the plant operation, along with ambient harmonics, must be considered.
- Normal and contingency filter conditions must be considered.
- Harmonic emission must be estimated correctly under various operating conditions.
- System interaction with harmonic emissions must be considered.
- A three-phase modeling may be necessary where large unbalances exist.

II.4 SINGLE-TUNED FILTERS

The single-tuned (ST) filters are efficient filters and will bypass a certain harmonic to which these are tuned. These are most widely used filters in all applications of harmonic mitigation. However, care is required in their design, so that the components are not overloaded, and overvoltages due to their applications are controlled. Many times a group of ST filters are applied, each tuned to a specific frequency [22].

The operation of an ST shunt filter is explained with reference to Fig. 3. (Any other type of filter connected in the shunt can be termed a shunt filter.) Figure (a) shows a system configuration with nonlinear load, and Fig. 3(b) shows the equivalent circuit. Harmonic current injected from the source through impedance Z_c divides into filter and system equivalent impedance Z_{eq} . This system impedance can be found by circuit reduction – this is in fact the short-circuit equivalent impedance at bus 1.

The current I_s divides into three parallel paths: the current at PCC is the current flowing through utility source, and utility transformer is series:

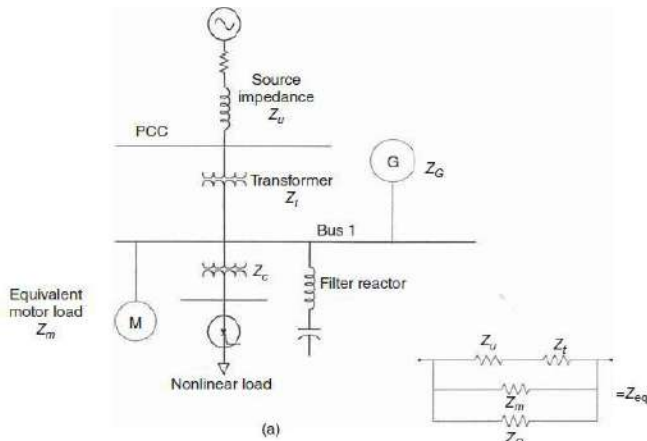


Fig.3(a): Connections of an ST filter, harmonic source in a distribution system.

Source: [22].

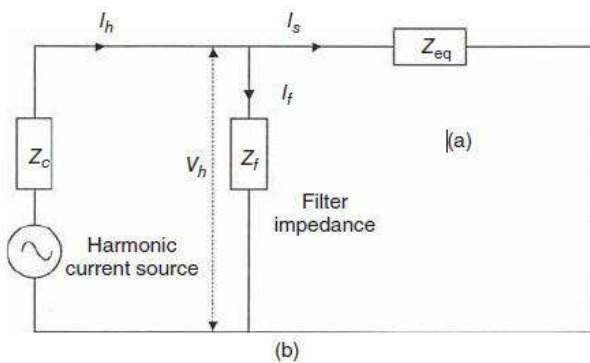


Fig.3(b): Equivalent circuit looking from harmonic injection as the source.

Source: [22].

We alluded to this concept in Chapter 6 in connection with active filters, the IEEE harmonic limits of TDD [27] are based on this concept. The higher is the short-circuit power of the source, the higher is the permissible TDD.

In an ST filter, as the inductive and capacitive impedances are equal at the resonant frequency, the impedance is given by the resistance R:

$$Z = R + j\omega_n L + \frac{1}{j\omega_n C} \quad (9)$$

At resonant frequency ω_n , $Z = R$.

The following parameters can be defined:

ω_n is the tuned angular frequency in radians and is given by

$$\omega_n = \frac{1}{\sqrt{LC}} \quad (10)$$

X_0 is the reactance of the inductor or capacitor at the tuned angular frequency. Here, $n = fn/f$, where fn is the

filter-tuned frequency and f is the power system frequency.

$$X_0 = \omega_n L = \frac{1}{\omega_n C} = \sqrt{\frac{L}{C}} \text{ and } \omega_n = \sqrt{\frac{1}{LC}} \quad (11)$$

The quality factor of the tuning reactor is defined as

$$Q = \frac{X_0}{R} = \frac{\sqrt{L/C}}{R} \quad (12)$$

It determines the sharpness of tuning, see Chapter 3. The pass band is bounded by frequencies at which

$$|Z_f| = \sqrt{2}R \quad (13)$$

$$\delta = \frac{\omega - \omega_n}{\omega_n} \quad (14)$$

$$\omega = \omega_n(1 + \delta)$$

At these frequencies, the net reactance equals resistance, capacitive on one side, and inductive on the other side. If it is defined as the deviation per unit from the tuned frequency, then for small frequency deviations, the impedance is approximately given by

$$|Z_f| = R\sqrt{1 + 4\delta^2 Q^2} = X_0\sqrt{Q^{-2} + 4\delta^2} \quad (15)$$

To minimize the harmonic voltage, Z_f should be reduced or the filter admittance should be high as compared to the system admittance.

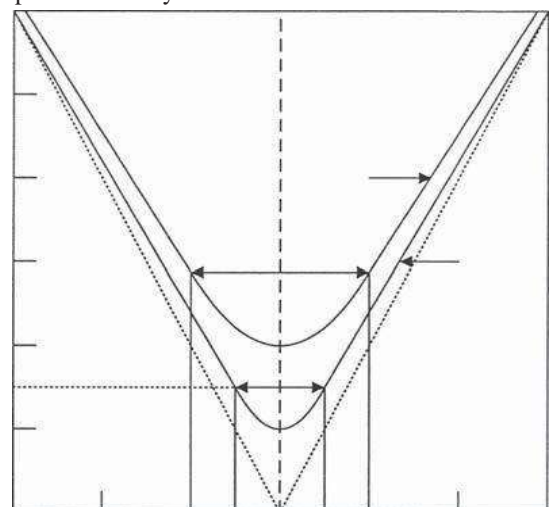


Fig.4: Response of an ST shunt filter showing pass band and asymptotes.

Source [28].

The plot of the impedance is shown in Fig. 4 [28]. The sharpness of tuning is dependent on R as well as on X_0 , and the impedance of the filter at its resonant frequency can be reduced by reducing these. The asymptotes are at

$$|X_f| = \pm 2X_0|\delta| \quad (16)$$

The edges of the pass band are at $\delta = \pm 1/2Q$ and width = $1/Q$. In Fig. 15.4, curve A is for $R = 5$ ohms, $X_0 = 500$ ohms, and $Q = 100$, with asymptotes and pass band, as shown. Curve B is for $R = 10$ ohms, $X_0 = 500$ ohms, and $Q = 50$. These two curves have the same asymptotes. The resistance, therefore, affects sharpness of tuning.

In terms of admittances

$$Y_f = G_f + jB_f \\ = \frac{Q}{X_0(1 + 4\delta^2 Q^2)} - \frac{2\delta Q^2}{X(1 + 4\delta^2 Q^2)} \quad (17)$$

The harmonic voltage at filter bus is

$$V_h = \frac{I_h}{Y_h} \quad (18)$$

For minimum voltage distortion, the overall admittance of filter should be increased. The impedance loci indicate that generally the harmonic impedances can be defined in a region of R, jX , determined by two straight lines and a circle passing through the origin.

The other types of filters that were used in article [29] have the same characteristics of the search:

- a) *Filters tuned*
- b) *Damped Filter (High pass)*
- c) *d) Third-order filter*
- d) *C type filter*

III. MATERIAL AND METHODS

The research follows the same methodology of Article [29]:

- A. *Formulation of the problem*
- B. *Problem variables*

The chromosome representing an individual's data consists of an arrangement of the K elements, where each Sk element as shown in Table 1 is an arrangement of integer and real data representing the various parameters of the harmonic filter to be located on bar k .

Table.1: Variables that describe a filter represented on the chromosome.

Variable	Description
Cfg	ConfigurationType (1, 2, 3, 4)
m	Number of branches tuned (if it is type 1 filter)
Qc	Total reactive power in capacitors
Fd_1, \dots, Fd_{w+1}	Factors for the distribution of reactive power among all branches
Fq_1, \dots, Fq_{w+3}	Tuning frequencies of all branches
Q_1, \dots, Q_{w+3}	Quality factors of all branches

Source: [29].

IV. RESULTS AND DISCUSSIONS

The results of the research follows the same methodology of article [29] using case 2.

NPV of filters design [29] and equations (8), (9), (10), (11), (12), (13), (14), (15), (16), (17), (18), (19), (20), (21), (22), (23), (24), (25), (26) and (27).

4.1 OTIMIZATION ALGORITHM

For the problem formulated for the design of filters whose nonlinear features with real and integer variables whose solution requires an optimization algorithm using the NSGA II. The types of optimization problems present several objective functions, which are almost always in conflict, and if one wishes to optimize simultaneously in this case, in an innovative way, it presents three objective functions ($f1$, $f2$ and $f3$). In multiobjective optimization, the notion of optimal solution is replaced by the notion of Pareto unpaired or optimal solution [29][31].

4.2 APPLICATION EXAMPLES

This example corresponds to an industry that contains medium and low voltage loads. The electrical system uses a primary distribution network of 4160V that feeds the medium voltage loads and four substations that feed the loads of 480V. The nonlinear loads are concentrated in the low voltage part and are formed by three-phase six-pulse converters.

In this case it is considered that the voltage of all the nodes of the network must comply with the quality indicators as established in the standard [32]. The industrial plant is described according to the singleline diagram shown in Figure 5.

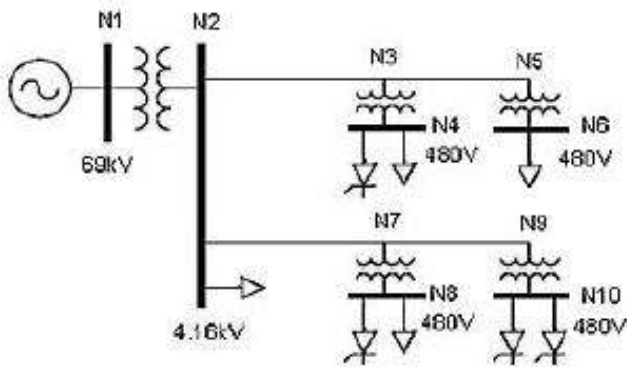


Fig.5: Industrial plant single line diagram.

Source: [29].

Os dados que descrevem a instalação industrial estão apresentados e para o processo de otimização, são considerados cinco cenários de operação possíveis, os quais são apresentados na Tabela 2.

Tabela 2: Cenários para as análises.

Parâmetro	Cenários				
	1	2	3	4	5
Duração diária do cenário (h/dia)	6	10	8	0	0
Depreciação da capacitância dos filtros ΔC (%)	0	0	0	0	10
Depreciação da indutância dos filtros ΔL (%)	0	0	0	-5	5
MVA de curto-circuito no PCC (MVA)	250	250	250	125	125

Source: Authors, (2019).

The first three scenarios are load regimes characteristic of a normal industrial plant work day, considered to evaluate the 12-month energy bill with 30 days. These scenarios do not consider depreciation of the filters components, since they assume that they exactly maintain their design parameters. Scenarios four and five are pessimistic conditions of network operation with reduced short-circuit MVA in the PCC [29]. In addition, these scenarios add a depreciation of capacitance (ΔC) and inductance (ΔL) for all filters that are installed. The bars (N4, N8 and N10) were selected for the installation of filters considering that they are the ones that feed nonlinear loads [29]. To evaluate the economic effectiveness (NPV) of the compensation project, it was considered a duration of five years, with a rate of return of 10% per year. The following cases were analyzed [30]:

1) Design of filters for the three characteristic scenarios;

2) Design of filters for the five possible scenarios.

In both cases, the limits of voltage harmonics [32] were used as energy quality constraints.

In addition, 100 generations of the algorithm were performed, with a population of 500 individuals.

4.3 DESIGN OF THE FILTERS FOR THE THREE CHARACTERISTIC SCENARIOS

In this case, by adding two non-characteristic scenarios that complicate the problem, they may have a modern scenario for all scenarios. As the voltage distortion rates increased, as in the previous case, there were no violations of the PRODIST Module 8 standard, which can be seen in Table 3.

Table 3: Initial results (case 2).

Parâmetro	Valor
Custo anual da energia (\$/ano)	840124
Máximo TDD (%)	7.412
Máximo IDD (%)	6.498
Máximo THD (%)	9.090
Máximo IHD (%)	6.818
Fator de potencia	0.797

Source: Authors, (2019).

According to [29][31], these levels of distortion are within the established limits. Finished 100 generations, the genetic algorithm produced a population of 500 solutions, for example. Extracting only viable solutions, the results obtained are shown in 9 for the Pareto frontier of the problem, as shown in figure 6.

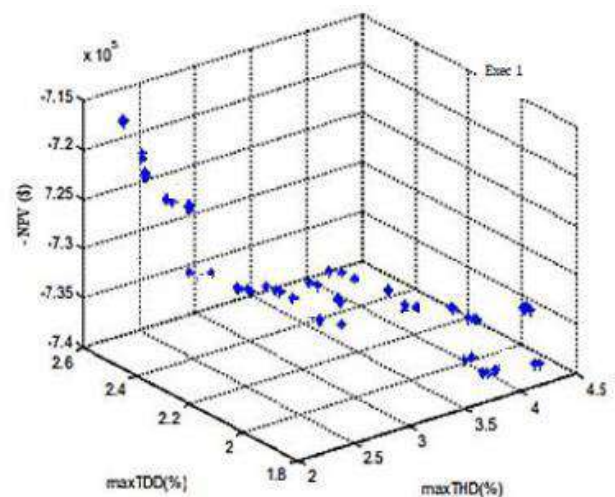


Fig.6: Pareto frontier.

Source: Authors, (2019).

In order to select the possible solution to the problem, considering that the PRODIST-Module 8 standard only restricts the voltage distortion, we can order the solutions in ascending order of $maxTHD$, $maxTDD$

and $-NPV$ respectively. Figure 8 shows the ordered solutions, where $asmaxTHD$ increases, $maxTDD$ and $-NPV$ decrease [29][30].

A Figura 7 mostra as soluções ordenadas para o novo caso, onde se repete o comportamento observado previamente.

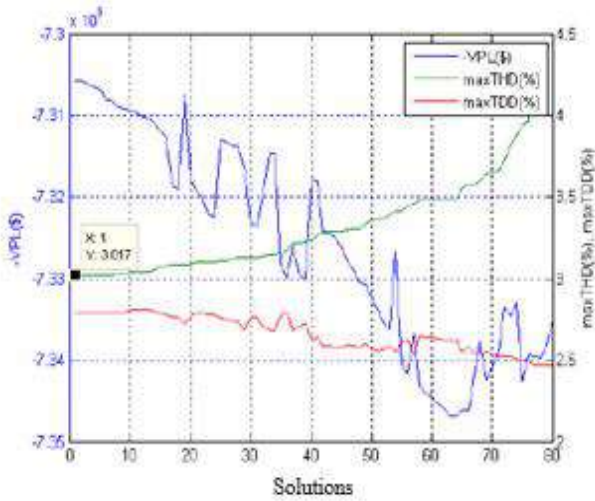


Fig.7: Ordered solutions (case 2).

Source: Authors, (2019).

The solution chosen, shown in Figure 7, is composed of the filters whose parameters are shown in Table 4.

Table 4: Parameters of selected filters (case 2).

Barra	Parâmetro	Ramo 1	Ramo 2
N4	Tipo	2ª ordem	
	Capacitor	8x50 kvar	
	Frequência	5.6	
	Fator de qualidade	5.8	
N8	Tipo	2ª ordem	
	Capacitor	4x50 kvar	
	Frequência	5.5	
	Fator de qualidade	5.8	
N10	Tipo	sintonizado	sintonizado
	Capacitor	4x50 kvar	2x50 kvar
	Frequência	4.7	6.6
	Fator de qualidade	41.3	22.7

Source: Authors, (2019).

For these filters, the results of Table 5 are obtained, which demonstrate an appreciable reduction of the distortion limits, and a good NPV of the design is expected.

Table 5: Final results (case 2).

Parameters	Value	%
Annual energy cost (\$/year)	637442	75.875
Max TDD (%)	2.795	37.711
Max IDD (%)	2.481	38.177
Max THD (%)	3.017	33.191
Max IHD (%)	2.594	38.040
Power Factor	0,982	123.218
Cost of filter investments (\$)	37751	
Project NPV	739857	

Source: Authors, (2019).

As can be seen, in Figure 8, these filters have a very stable performance against the variations of their parameters L and C.

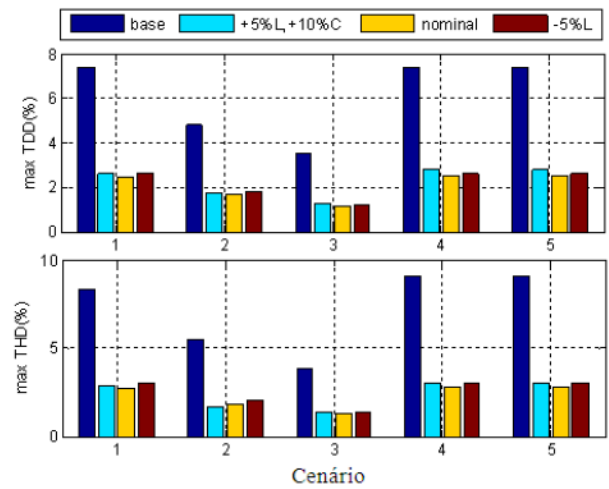


Fig.8: Results with filter depreciation (case 2).

Source: Authors, (2019).

Thus, the frequency sweep results in Figure 9 show that the impedance peaks do not match the present harmonics and therefore the selected filters can operate without problems.

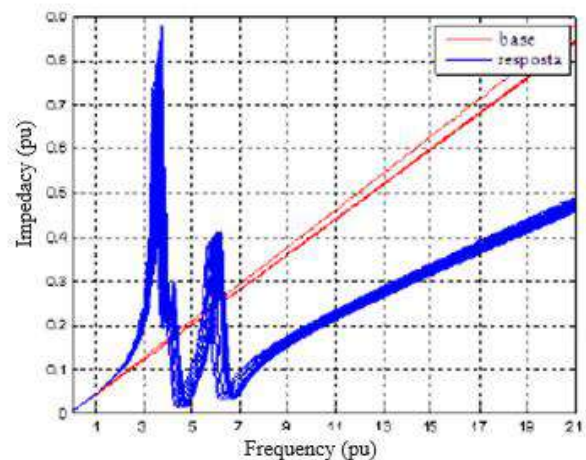


Fig.9: Frequency scanning on bar N10.

Source: Authors, (2019).

As cases 1 [29] and 2 are very similar, the results were compared for the TDD and THD distortion rates of the solution variants applied in case 2, hoping that the variant found in this case is better, especially for the scenarios 4 and 5. The results are shown in Table 6.

Table 6: Comparison between solutions 1 and 2 for case 2.

Index	Solution	Scenario					Max
		1	2	3	4	5	
maxTDD	1	2.596	1.699	1.234	2.445	4.450	4.450
	2	2.469	1.655	1.139	2.617	2.795	2.795
maxTHD	1	2.346	1.564	1.100	2.369	4.134	4.134
	2	2.742	1.834	1.280	3.017	3.017	3.017

Source: Authors, (2019).

As expected, the solution of case 2 behaves better than the solution obtained for case 1.

V. CONCLUSION

From the results obtained, the following conclusions can be drawn:

1) In order to obtain good results, it is necessary to use populations that exceed several times the number of variables of the problem. The cases considered with three filters were applied with populations of 500 elements (individuals per variable).

2) The responses obtained usually use capacitors of different powers for the different branches of a filter. This is different from the proposals of several authors, who use the same capacitors for the different branches.

3) Due to the characteristics of the genetic algorithms, there is no guarantee that the type of filter configuration chosen by the algorithm is the best. It is noticed that the algorithm will produce a set of good solutions to the problem. Therefore, the program (NSGA II) has the option to restrict the possible solutions to choose and prefix the desired configuration in each case.

4) It is necessary to improve the tools for the selection of the final variant, from the set of viable solutions, determined by NSGA II.

5) The solutions obtained with the algorithm should be analyzed for different conditions of capacitance depreciation and inductance of the filters and, in this way, correctly judge the performance of the selected filters.

6) The optimization algorithm (NSGA II) developed can adapt significantly to the parallel programming with which it would drastically reduce the execution time of the algorithm.

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REFERENCES

- [1] Weedy, Birron Mathew et al. Electric power systems. John Wiley & Sons, 2012.
- [2] Whitaker, Jerry C. AC power systems handbook. CRC Press, 2006.
- [3] Qazi, Sajid Hussain; Mustafa, Mohd Wazir. Review on active filters and its performance with grid connected fixed and variable speed wind turbine generator. Renewable and Sustainable Energy Reviews, v. 57, p. 420-438, 2016.
- [4] Heydt, Gerald Thomas. The next generation of power distribution systems. IEEE Transactions on Smart Grid, v. 1, n. 3, p. 225-235, 2010.
- [5] Ghosh, Arindam; Ledwich, Gerard. Power quality enhancement using custom power devices. Springer Science & Business Media, 2012.
- [6] Kothari, Dwarkadas Pralhadas et al. Modern power system analysis. Tata McGraw-Hill Education, 2011.
- [7] Morán, Luis A. et al. Using active power filters to improve power quality. In: 5th Brazilian Power Electronics Conference. 1999. p. 501-511.
- [8] Duffey, Christopher K.; Stratford, Ray P. Update of harmonic standard IEEE-519: IEEE recommended practices and requirements for harmonic control in electric power systems. IEEE Transactions on Industry Applications, v. 25, n. 6, p. 1025-1034, 1989.
- [9] Cristaldi, Loredana; Ferrero, Alessandro; Salicone, Simona. A distributed system for electric power quality measurement. IEEE Transactions on Instrumentation and Measurement, v. 51, n. 4, p. 776-781, 2002.
- [10] [10] Gomez-Exposito, Antonio; Conejo, Antonio J.; Canizares, Claudio. Electric energy systems: analysis and operation. CRC press, 2018.
- [11] [11] Sankaran, C. Power quality. CRC press, 2001.
- [12] [12] Das, J. C. Passive filters-potentialities and limitations. IEEE Transactions on Industry Applications, v. 40, n. 1, p. 232-241, 2004.
- [13] [13] Gonzalez, Damian A.; Mccall, John C. Design of filters to reduce harmonic distortion in industrial power systems. IEEE Transactions on Industry Applications, n. 3, p. 504-511, 1987.
- [14] Arrillaga, Jos; Watson, Neville R. Power system harmonics. John Wiley & Sons, 2004.
- [15] Ellis, Robert G. Harmonic analysis of industrial power systems. IEEE Transactions on Industry Applications, v. 32, n. 2, p. 417-421, 1996.
- [16] Kuffel, John; Kuffel, Peter. High voltage engineering fundamentals. Elsevier, 2000.
- [17] Alemam, Ali Mohammednoor Ali et al. Power System Harmonics Sources, Effects and Elimination. 2018. Tese de Doutorado. Sudan University of Science and Technology.

- [18] Radhakrishnan, Krishna. Passive Filter Design and Optimisation for Harmonic Mitigation in Wind Power Plants. 2016. Dissertação de Mestrado. NTNU.
- [19] Vedam, R. Sastry; Sarma, Mulukutla S. Power quality: Var compensation in power systems. CRC press, 2008.
- [20] Quintana Barcia, Pablo José. Study on active filtering of current harmonics content in public lighting systems. 2013.
- [21] Tan, Adnan; Bayindir, K. Çağatay. Modeling and analysis of power quality problems caused by coreless induction melting furnace connected to distribution network. *Electrical Engineering*, v. 96, n. 3, p. 239-253, 2014.
- [22] Das, J. C. Power system harmonics and passive filter designs. John Wiley & Sons, 2015.
- [23] Leite, J. C. Abril, Ignácio Perez, Tostes, Maria Emília de Lima and Oliveira, Roberto Célio Limão de. Multi-objective optimization of passive filters in industrial power systems. *Electrical Engineering*. Springer. 2016. DOI: 10.1007/s00202-016-0420-3. Volume 99, Issue 1, pp 387–395.
- [24] Chapman, David. Harmonics causes and effects. *Power Quality Application Guide*, v. 3, p. 4-5, 2001.
- [25] Merhej, Saad J.; Nichols, William H. Harmonic filtering for the offshore industry. *IEEE transactions on industry applications*, v. 30, n. 3, p. 533-542, 1994.
- [26] Beres, Remus Narcis et al. A review of passive power filters for three-phase grid-connected voltage-source converters. *IEEE Journal of Emerging and Selected Topics in Power Electronics*, v. 4, n. 1, p. 54-69, 2015.
- [27] IEEE 519-2014. Recommended practice and requirements for harmonic control in electrical systems, 1992. Review to 2014.
- [28] E.W. Kimbark. *Direct Current Transmission*, Chapter 8. John Wiley, New York, 1971.
- [29] Leite, J. C et. al.. Approach of Passive Filters using NSGA II in industrial installations: Part I. *International Journal of Advanced Engineering Research and Science (IJAERS)*. [Vol-5, Issue-8, Aug- 2018].
- [30] Kawann, C., & Emanuel, A. E. (1996). Passive shunt harmonic filters for low and medium voltage: A cost comparison study. *IEEE Transactions on Power Systems*, 11(4), 1825-1831.
- [31] ANEEL, P. d. D. d. E. (2018). Elétrica no Sistema Elétrico Nacional–PRODIST: Módulo 8-Qualidade de Energia Elétrica. *Revisão*, 10, 88.

Small Leaves: Children in the Temples of Candomblé in the Backwoods of Brazil

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Abstract— *This study is a reflection of the realities experienced by three children and one adolescent from three Temples of Candomblé in the cities of Juazeiro / BA, Petrolina / PE and Paulo Afonso / BA (Sertão Nordestino Brasileiro), whose main objective was to describe, under their own perceptions, how their relationships are established in the process of participation (initiation, teaching and learning of knowledge) in these spaces of Afro-Brazilian religious cults. Two children were interviewed by ethnographic research in Terreiro Bandalecôngo de Mãe Maria de Tempo, in Juazeiro / BA; a child in the Terreiro Ilé Dará Axé Omo Logum Edé of Pai Adilson, in Petrolina / PE and; a teenager in the Abassá of the Goddess Oxum de Idjemim, in Paulo Afonso / BA. The method used was that of Content Analysis, according to Bardin (2016). It was concluded that the relationships involving children, childhood, religion, family and community are fundamental for the construction and (re) elaboration of knowledge and to know in the process of teaching and learning inside and outside the temples.*

Keywords— *Children and adolescents. Temples of Candomblé. Participation and initiation. To know. Backwoods of Brazil.*

I. INTRODUCTION

Corsaro (2011) concluded that, through the traditional theoretical conception, in which much of the sociological thinking about children and infants derives from the theoretical work on socialization, a process by which children adapt and internalize society, the child is seen as society, which must be shaped and guided by external forces in order to become a fully functional member. He tells us that in the deterministic model the

child plays primarily a passive role, in which he is both a "beginner" with potential to contribute to the maintenance of society and an "untamed threat", which must be controlled through careful training. Still for this author, in the constructivist model, the child is seen as an active agent and an avid apprentice, perspective in which the child actively builds his social world and his place in it.

Caputo (2012) reports that, as a researcher, she tries to "frame" aspects of reality and to cut down from

the observed immensity a smaller immensity, on which one can look more closely and that the temple offered her the infinite, but focused on her attention on talking, interviewing and photographing especially the children, relating them to the community of the temple as a whole.

Taking these conceptions as a guide to arrive at a possible description / understanding of the processes that involve children in learning and in the socialization of the knowledge and knowledge of the religions of African matrices, more specifically Candomblé in the Brazilian semiarid region, semi-structured interviews with

three children and one adolescent from three Candomblé temples in three Brazilian cities.

From Bandalecôngo temple (Juazeiro / BA), the children interviewed were Kerlen, eight years old, initiated in candomblé at age seven, and Naian ten years old, started in religion when she was six years old; From the Temple Ilê Dará Axé Omo Logum Edé (Petrolina / PE), the seven-year-old David, who started at the age of four, ; From the Abassá of the Goddess Oxum de Idjemim (Paulo Afonso / BA), the content analyzed was that of Leticia, thirteen years old, initiated at the age of ten.

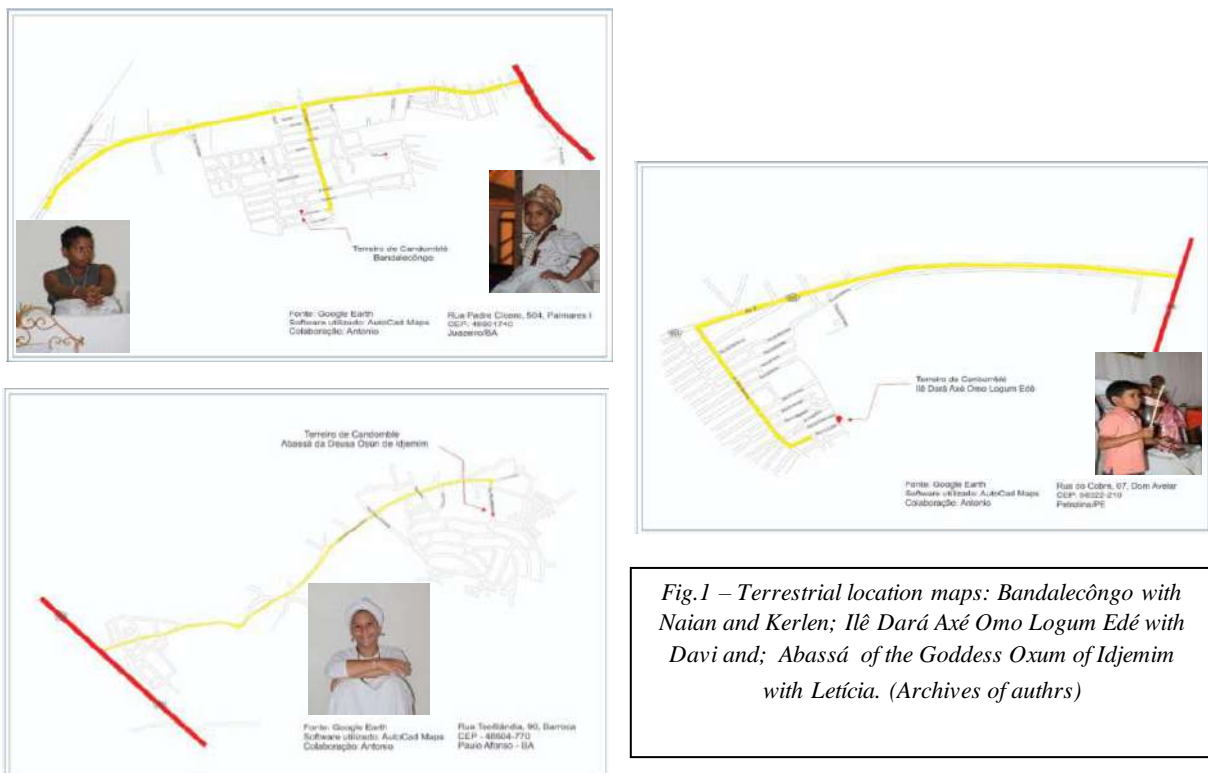


Fig.1 – Terrestrial location maps: Bandalecôngo with Naian and Kerlen; Ilê Dará Axé Omo Logum Edé with Davi and; Abassá of the Goddess Oxum of Idjemim with Leticia. (Archives of authrs)

II. MATERIALS AND METHOD

Based on the identification of the scenario, the research adopted as a strategy data collection as a case study, considered by Oliveira (2008) as an initial study of few known problems or when there are few or a single case available to study ", or by the understanding of GIL (2010) that is based on a strategy for very numerous data and obtained in different ways.

According to an ethnographic study, the research coincides with the idea of Macedo (2015) evidencing that the experience of the other is placed in the research with the status of a different way of creation and apprehension of knowledge and that this experience happens in between us, in the between-two, provided by interactions in the same research process. For the author, the researcher and the social actors involved, via generative encounters, produce the heuristic of research,

the cognitive modes, very intuitively, to arrive at the discoveries.

The data collected by semi-structured interviews were grouped, systematized and categorized in thematic axes, then in analytical topics and finally in this scientific production (article). The analysis of the data collected in the field was based on the Content Analysis - French Line AC, based on the studies of Bardin (2016), which proposes the categorization of discourse content as one of the possible methods of analysis.

III. RESULTS AND DISCUSSION
Childhood in Human Ecology of Candomblé temples in the semiarid of brazil

Kileuy and Oxaguia (2011) argue that the word "candomblé" seems to have originated from a term of the Bantu nation, candombe, and translated as dance and batuque, referring to jokes, parties, meetings, slaves

feasts, in the slave quarters, in their spare moments. Also, it is a religion that was created in Brazil through the cultural, religious and philosophical heritage brought by Africans, adapted to the environmental conditions and with the primary function of worship the divinities - iniquices, orixás or vuduns -, beings that are the strength and power of nature.

Regarding his activities in the temple, Kerlen, a child from Bandalecôngo's temple, says that he helps Yalorixá by separating food and things from cleanings to get through the body when cleaning or initiating, and that her temple is candomblé. Her imagery seems surprising when she elaborates her Human Ecology by linking Africa to the Northeastern Semiarid by describing that she likes zebras, which has two dogs and her palate is attracted by the sweet taste of grape fruit.

Naian, also a child of Bandalecôngo, says that inside the temple, he does many things: "I play, when there is a party, help my mother in at the ebó ritual, move the ebó from a place to another" And that he himself defines himself, functions, such as a "Keligebo"². The small candomblecist claims to be also Ogã.

Naian still claims to be from Candomblé, inferring distinction between candomblé³ and Umbanda: "It's that he sings some songs that are already very different in Umbanda." He also says that he likes and cares about nature and plants and that between dealing with "bugs" and with people, it's easier with the bugs, because the people from outside, keep saying things about us. Criticizing".

Davi, child of Ilê Axé Dará Omo Logum Edé, affirms to be Ogã⁴, who likes to play drums and that deal

with animals in a natural way. He also assumes that he is from Candomblé, verbalizing his conceptual defense of what differentiates Candomblé from Umbanda: "Umbanda plays drums and Candomblé plays atabaque". He also describes how he takes care of the plants: "I drink water and leave it in the sun." And why I like snakes and not fear them: "because I snake's", alluding to his head Orixá, Oxumaré.

The child sketches naturality when he speaks about his father and his uncles (who are also ogans) in the rituals and already carries out the immolations to offer to the deities. In the position of Alabê, Davi helps his father and uncles in specific jobs of Ogã Axogum.

In this respect Caputo (2012) tells us that:

There are innumerable children and adolescents in the afro-Brazilian cults community. They are either from the family of the father or mother of a saint or are attached to the sons and daughters of the saint of the temples. Like adults, these children are initiated into candomblé, perform specific functions, receive positions in the hierarchy of the temples and manifest pride in their religion (CAPUTO, 2012).

The adolescent abbess of the Abassá of the Goddess Oxum de Edjemim, Leticia Maria, when asked about what she does in the temple, she was a little shy and / or tense enough to answer "I am Abián in the temple." She says she never went to a Umbanda temple, but with aplomb She assumes that She is from Candomblé and goes on to argue:

For me candomblé is a religion that is equal to the Catholic. But in the Catholic the names of the saints are others. Our Lady of Aparecida is Iemanjá, Our Lady of the Conception is Oxum. It's different, but it's the same. And the language is different, but it is based on the Catholic Church. It is a ritual of faith (LETÍCIA, 08/08/17).

She makes an association in the relationship of religion with nature and warns about the ecological behavior of man on the elements:

It is very much the same because the snake, for example, has a god who dominates it, which is Oxumaré. There is the forest that manages the Oxossi and Ossaim leaves. There is mud that is the Nanã, there is the freshwater river that is the Oxum. There is salt water that is Iemanjá. Everything is all about the reality of Candomblé. I think candomblé is more the reality of nature than the Catholic church.

¹For Kiley and Oxaguã (2011) the sense of "doing ebó" is based on rituals that allow the strengthening of the spiritual life, but also part of the rituals that help to remove the negative forces that bring instability. They are elements that can be offered to Exu, eguns and Edus and also to the orixás and other deities.

²From the speech of Naian the sense apprehended is the one who deals with ebó, although according to his mother kota he doesn't detain the position of kelegebo.

³For Prandi (2003), Umbanda is an Afro-Brazilian branch and was formed in the 20th century in the Southeast, and represents a synthesis of the ancient Candomblé of Bahia, transplanted to Rio de Janeiro in the passage from the 19th to the 20th centuries, the Kardecist spiritualism, which came from France at the end of the nineteenth century (MARQUES and NOVAES, 2015, p.33).

⁴Male authorities, hierarchical rank below the priest / priestess, and their direct auxiliaries, so called by the Yoruba people. In the fon nation they are called runtó / huntó and in the bantu nation they are called xicaringome / xincarangoma. These men, like the equedes, do not enter into a trance (Kiley and Oxaguã, 2011, 60).

But man has to be aware of what he is doing. Example: Is there a god that will tell you what you have to do? No! It has to come from you, not from others. Because more and more people find a cleared forest. The people always ask why it does not rain or why it rained there and it did not rain here. Maybe where it did not rain was where everything was cleared and where it rained is because they preserved it (LITICIA, 13/08/17).

Corsaro (2011) describes us that interpretive reproduction views the integration of children into their cultures as reproductive rather than linear. For him, from this reproductive perspective, children do not simply imitate or internalize the world around them. According to the author, they (children) strive to interpret or give meaning to their culture and to participate in it. In this attempt to make sense of the adult world, children collectively produce their own worlds and cultures of peers.

According to Tomaz (2014), the symbolic relationship established between traditional peoples and communities and nature, constitutes an ethnoecology of preservation and care and that the vulnerability to which they are subjected can be understood by the historical construction in which these differentiated groups had to submit, from Brazil colony to contemporaneity.

Higino (2011) concludes that the social space of the temple, is a religious space and also an educational one, since it is in the coexistence that the exchange of knowledge is established, since the religious heritage brings with it, throughout the history, a context of resistances and social oppressions that lead the Negro to exercise his citizenship and define his identity and conscience. For the author in the education of Candomblé there are values transmitted because they are linked to spirituality and the basis of their existence is the transmission of fundamentals and doctrines, orally, by the elders.

Thus, in the children's and adolescent's speech, we can see an interaction that directly relates religion, nature (environment), society / community, cultural symbols in their own conditions as a child in an interpretative perspective, following Corsário (2011), because of adult cultural reality participate, but also re-elaborate and re-signify their interaction, describing this relationship as the driving force that binds them, in rituals, also to the deities, but mainly fun, as ecological connection in the representation of Orixás that have as main characteristic care and / or symbolism with the elements of nature, for example, Oxumarê (whose representation is the snake) and / or Oxossi (guardian of

the woods), among others, in a connection between the human and the sacred.

Initiation in Candomblé: Perceptions of Children from Brazilian semi-arid temple

Leonardo Boff, in dealing with the ethical principles of unlimited responsibility and respect, tells us that "responsibility, fundamentally, has to do with the conscience of the human being, of him realizing the consequences of his acts" and that respect is "the attitude towards the other: when we respect, we guarantee the right that things exist" (BOFF, s / d).⁵

In "The Voice of Time: the Winds of the Bandalecôngo temple"⁶ the Yalorixá Mother Mary of Time tells us that Initiation is the birth to a new life and that in the houses of nation Keto, there is the tradition of shaving the head of the iaô, during the process of making the saint, while the person is collected (period ranging from 14, 21 and 30 days) depending on the particularities of the initiate's personal life. For her, the scraping of the head means that that person is leaving everything to start again to live with a clean and pure head to receive the teachings that will be governed by the Orixá of his Ori.⁷ (MARQUES, ALVES and MARQUES, 2017).

As the children and adolescents of the semi-arid Brazilian temples perceive themselves as part of a religion with many marks of resistance due to prejudice and discrimination that are still violently stuck in the memories, bodies and established human relationships, including (schools), and how they describe their experiences is what the interviewees of this research reveal.

According to Kerlen, at school the students know she is a candomblecist and that, "they question her like this: Kerlen, how do you dance? Then I'm kind of lost. Then I will soon do my activity." In this respect, it is pertinent that the Yalorixá Mother Mary of Time, who is Mother of Saint and biological grandmother of Kerlen bear his testimony at the stage in which Kerlen made himself "in the Holy:

⁵This is a documentary available on networks and social platforms, which was accessed on 09-02-2018 (<https://www.youtube.com/watch?v=6YFTh2yEPIk>), but does not have the date of its production.

⁶Book organized by Juracy Marques, Maria Rosa de Almeida Alves and Robson Marques.

⁷It is the name of our physical head for the Yoruba; camutuê or mutuê for the bantus; and is for the Fon nation. The ori is a divinity that serves only his son, since it is individual and unitary (KILEUY and OXAGUIÁ, 2011).

Kerlen shaved her head, went to school, she had a cap. We made a nice little white cap, put it on and it was like a toupee, and they always asked why she did not take off her cap. So she said, "No, no problem, you want to see?" Then she took it off. She talks too much. She also said, "Listen, there's nothing much. Look! That's hair, hair grows out fast. It's going to be all over again, my curls will come back all over again." She is like that (MOTHER MARIA DE TEMPO, 07/17/17).

It is important to point out that one of the hallmarks of the initiation process in Candomblé, also in the Brazilian semi-arid, is the rite of shaving the head and the recollection in a room (Honkó, camarinha) for learning fundamentals such as greetings, songs, dances, what to eat or stop eating to be in harmony with the Orixá that will govern the life of the initiate from the making. This process is followed and directed directly and constantly throughout the period of recollection by a person of great doctrinal knowledge within the temple called Makota or Mother Cota. And, because it characterizes, especially in long-haired women, a radical change of vision has been described as the most common form of prejudice, discrimination and intolerance that people in candomblé experience.

From his process of initiation into religion what Kerlen describes from his memoirs is that he began at the age of seven, who attended a party in the hall of the temple, which had many people and who did not wonder about the shaved head because "the hair grew out and at school no one said anything." As for his head guides, he reveals that they are Iansan and Oxossi.

Naian relates a situation at school with her colleague when she was asked if she had any problem with being a candomblecist:

If so ...? It was just once that I told my classmate. But I asked him not to tell anyone. Then he said he did not like my religion, that he was my best friend at school. Then he said that I was a sorcerer, that I was going to cast a spell on him. Then I did not like it. Then I ended friendship with him. Then he threw a stone at me. Then I did not talk to him anymore (NAIAN, 07/23/17).

And when asked if his teachers and other colleagues at school know that he is a candomblecist, he says: "Only my cousin." She also says she does not tell her colleagues and teachers, only the principal, because she does not have the courage to tell them. "Because they keep calling me a sorcerer and I do not like it. And I do not like messing around."

But it is when Naian tries to describe what he feels when he is called sorcerer that we perceive a possible disorder in his attempt of conceptual (re)elaboration and of religious meaning: "spell maker is ... is not ... it is the same thing of Candomblecist .. I do not know how to explain well."

Asked about his inspiration to be from candomblé he says: "it is because I saw my mother there then I encouraged myself a lot. Then I wanted to join them." "For me ... I do not remember, but I think I just chose it." And he reveals that his front guides are: "Oxossi and Oxalá, Iemanjá and Oxum come later."

It is inferred from the content of Naian's statements that his religious reality is in constant conflict with the glances of his religion in the daily life at school by the relation reported with his colleague but that it is sustained by the conviction of the experiences with his biological mother and also a saint.

David told only that he has a colleague who is from another temple, and at school nobody did not notice anything different with him. He, with unusual responses of his age, says that it was from his Uncle Mida that he learned to play. And when asked what methods his uncle used to teach him, true and childish, he answers: "Teaching! I looked and learned." This speech translates one of the ways in which education in the temples occurs: still strongly based on oral tradition, children just observe, listen and learn.

Leticia reveals to us that for making part of Candomblé temple has already been discriminated against, has already gone through some prejudiced situation:

There's a classmate of mine, from school, that's a Christian. She does not believe in this and such. If I wear a necklace like that I'm already a macumba maker, I'm already the one who casts spell on people and such. Then when I got there she would start saying things, start laughing at me. Then, at religion class, the teacher started talking about Candomblé and asked who was from Candomblé. I said I was and there was another classmate who was too. Then the Christian girl started talking and all. Then I said: the same way I respect your religion, you should respect mine. I make my choice, you make yours. I told her that and nothing more. And today she is ok about my religion. She never said anything again. I wear the necklace and such, I no longer said anything again (LETÍCIA, 08/08/17).

For Leticia, a situation of discrimination faced in the school, did not make her feel victimized, on the

contrary, she used the situation in the classroom to declare herself a candomblé member and have the other students respect her as such. By her statement Leticia seems to be steadfast about his religious choice and to give us a good lesson: do not shut up before the oppressor and be proud of what you do with love and devotion.

IV. FINAL CONSIDERATIONS

This work is concluded considering that, by the categorization that directed the speeches for the analyzes and according to semantic values in common, in the topic of Childhood of the Human Ecologies of the condimble temples in semiarid, it is established that the children and the adolescent, with their interpretations and (re) elaborations of reality describe their activities in the temple while maintaining the ingenuity and purity peculiar to their ages, establishing their childhoods in the context of religiosity and also as active and creative beings.

Kerlen and David saved the verbalization of the answers, but they were very attentive and charming by the detachment in the reelaboration of their realities. The content of David's speech, especially when he reports that "Umbanda plays drums and Candomblé plays Atabaque," seems to evidence a departure from the adult argument that entities, rites, touches, songs, offerings and, more generally, the rite of shaving or not shaving the head that represents this differential (distinction between candomblé and umbanda), ratifying its authentic interpretation.

Naian also involves the musicality when it is arranged to distinguish Candomblé of Umbanda, which is very pertinent, considering its condition also of Ogan. And that most likely discrimination from people externs their religion, which makes him understand better the beings who do not judge him: non-human animals, "the bugs."

It is also necessary to consider that Leticia defines Candomblé as a ritual of faith syncretized in Catholicism (Christian religion). Associating the elements of nature with the orixás, in her discourse, she compares her religion with the Catholic Church, enphasysing that candomblé experiences more the environmental reality and also relativizes the responsibilities signaling that, in the hierarchy of care, much is missing from the part of humans.

Regarding the feelings of their learning and initiation processes, the children and adolescents of the Brazilian semiarid temples describe how much play, beauty, knowledge and knowledge there is in playing drums, singing, dancing, assisting in ritualistic preparation, as well as to connect in different planes (the

terrain and carnal with the ancestral and divine) reelaborating and redefining, within its infantile perspectives, the cultural and religious realities of candomblé shared with the adults.

It can be inferred from Kerlen's speech that on the part of his colleagues there is more curiosity than discrimination when asked to see her dancing, but neither the questions nor the answers account for arguments capable of a conclusive conclusion. From Naian, it is inferred how violent it is for him to be labeled sorcerer to the point of not having the courage to tell his colleagues and teachers that he is from Candomblé, fearing more retaliation what may be putting him, like many, a position of religious invisibility.

And Leticia's sense of belonging is ratified by her entire history of dedication and reciprocity when her skills are properly cared for within the rites of her religion. Children in the temples, for Leticia, gain a sense of a reality with freedom and spontaneity in these spaces by the behaviors naturally experienced, which makes her speech special like a pearl due to the autonomy and authenticity of its descriptions.

Finally, we highlight how important it was to listen to the children themselves and the teenager about their lives, their choices and their participation in candomblé. Their speeches are strong winds against the whole mountain of prejudices, discriminations and structured intolerances against candomblé and, particularly, about the initiation of children in Afro-Brazilian religions. The constructions, interpretations and (re) elaborations of children, characteristic of the historical context of the black people confirm that the children of Candomblé of the Brazilian semiarid are Small Leaves that teach us great lessons.

REFERENCES

- [1] BARDIN, Laurence. Content analysis. Luiz Antero Reto and Augusto Pinheiro. São Paulo: Edições 70, 2016.
- [2] BOFF, Leonardo. Ethics and Ecology: Challenges of the 21st Century. Available at: <https://www.youtube.com/watch?v=6YFTh2yEPlk>. Accessed on: 09-02-2018.
- [3] CAPUTO, Stela Guedes. Education in the Terreiros and how the school relates to children from Candomblé. Rio de Janeiro: PALLAS, 2012.
- [4] CORSARO, William A. Sociology of Childhood. Translation: Lia Gabriele Regius Reis. 2. ed. Porto Alegre: Artmed, 2011.
- [5] GIL, Antonio Carlos. How to design research projects. 5. ed. São Paulo: Editora Atlas, 2010.
- [6] HIGINO, Mônica Estela Neves. The relationships of the candomblecist child in the social space of the school.

- Course Completion Work (Graduation in Pedagogy) - State University of Bahia, Salvador. 2011. 43f.
- [7] KILEUY, Odé; OXAGUIÁ, Vera de. Candomblé well explained: Notions Bantu, Yoruba and Fon. BARROS, Marcelo (org.). Rio de Janeiro: Pallas, 2011.
- [8] MACEDO, Roberto Sidnei. Search the Experience. Understand / mediate experiential knowledge. Curitiba-PR: CRV, 2015.
- [9] MARQUES, Juracy; NOVAES, Joaquin (org.). CANDOMBLÉ AND UMBANDA IN SERTÃO: Social Cartography of the Candomblé and Umbanda Terreiros of Petrolina / PE and Juazeiro / BA. Paulo Afonso: SABEH, 2015. 406p.
- [10] OLIVEIRA, Valéria Rodrigues de. Demystifying the Scientific Research. Belém: University Publishing House UFPA, 2008.
- [11] TOMAZ, Alzeni de Freitas. Law and Ecology of Peoples and Traditional Communities: Essay on Ethnography. In: MARQUES, Juracy (Org.). HUMAN ECOLOGIES. Feira de Santana: UEFS Editora, 2014. 393-417.

Food Ordering Management using Recommendations

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Abstract—The proposed food ordering management system enables the customer to order the food by selecting the food items from e-menu by registering on the web application or intranet of the institute. The system is useful for a canteen which faces lot of rush during the break time and also if the work in the canteen is manual such as taking food orders at the counter and subsequently calculating the cost. Also, there is dissatisfaction among customers due to delay in orders and orders not being attended for long. These issues are addressed and solved in the proposed system. In this project, we have proposed a system that can simplify most of the manual work in the canteen, from taking orders to calculating bills. Customers can order their food from anywhere in the institution using the website, making it a hassle-free task. The placed order will be displayed on the display screen and the staff will keep the order ready for the customer. Additionally, by making use of Apriori algorithm, recommendations will be provided to the customer. The proposed system will help the administrator of the system to have a clear idea, when and which food items are preferred more on a day-to-day basis.

Keywords—Apriori algorithm, Dataset, Food ordering system, Internet, Recommendations, Smart phone.

I. INTRODUCTION

The basic problem in the food services available at canteens at various institutes and organizations are that, they are not realizing the efficiencies that would result from better applications of technology in their daily operations. In canteens, ordering of food and calculation of bill is still a problem. The problem also arises when approximation of all the stock required to be bought has to be handled based on how much food was ordered and what will be ordered the most. There are many reasons leading to delays in services such as taking orders and serving which leads to dissatisfaction among customers. The project focusses on developing a user-friendly food ordering management system for the customers as well as the administrator. The proposed system will provide facilities to the administrator such as updating the menu, based on the recommendations given by Apriori algorithm and customer-based functionalities which includes placing orders by referring to the recommendations. Ordering of food will be lot easier.

II. LITERATURE REVIEW

2.1 Past work

In the food recommendation system using clustered database [2], the data is clustered after getting the input. Cluster is a set of similar items. Using cluster database speed of the system is increased and a lot of time is saved by reducing the number of comparisons. In this system K-means is used for clustering the items. It is efficient if the

amount of data is large. Here ingredients were listed using vectoring.

In an automated food ordering system [3], which will keep track of user orders smartly. This food ordering — system will allow the user to make order or make custom food by one click. This is an android application. The front end was developed using JAVA, Android and at the backend MySQL was used.

The Zigbee based e-menu ordering system [4], is useful for all kinds of restaurants and is affordable. The system has a smarter user interface for placing orders and billing. The system includes graphical representation of menu such that it is user friendly and understandable by illiterate people also. It is low cost alternative to bigger touch panels.

The proposed automated system [5] deals with automation of restaurants, with wireless touch-panel based menu systems. The orders are taken from customers using the digitized menu. Full menu of eatable items is displayed onto the touch panel for selection. Customer orders placed through the touch panels are received in the kitchen without any involvement of waiters. Zigbee was used to have wireless link of touch panels from kitchen to restaurant tables. PIC microcontroller was used for coding of menu on touch panel. The hardware implementation was done on PCB layout. Their proposed system would also take care of all paper work i.e. data handling.

The proposed automated system [6], aimed at minimizing the number of employees at the counter, elimination of

calculation error and avoiding long queues for efficient management. This proposed system had an admin module to help do required analysis. Data mining algorithms like Apriori, K-mean are used to perform association mining and clustering operations.

III. PROPOSED SYSTEM

3.1 Types of Users and their features

3.1.1 Admin

- Update menu
- Update inventory
- Recommendation (Most Frequently Ordered Dishes)

- Sales for each day, week and month

3.1.2 Staff

- View orders placed by customer
- Prepare ordered food
- Serve food once ready

3.1.3 Customer

- View Menu
- Place an Order
- View Bill

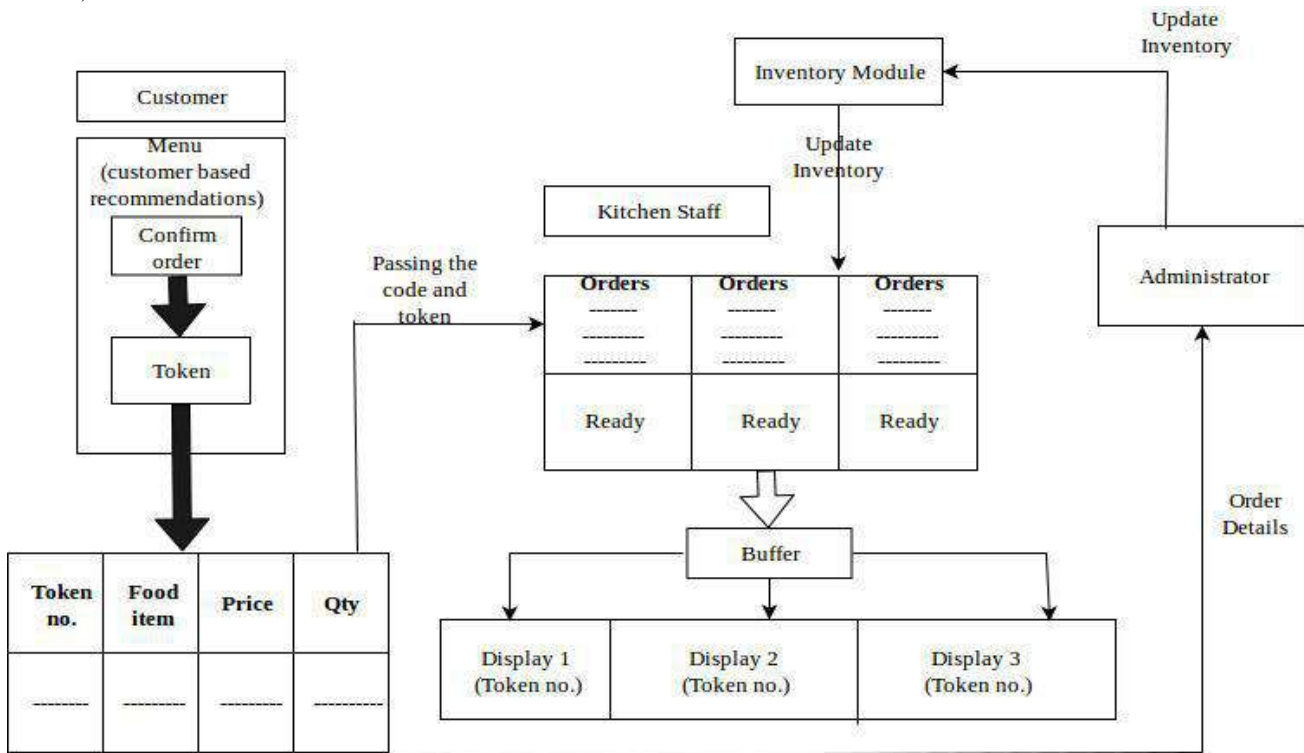


Fig 3.1 System Flow Diagram

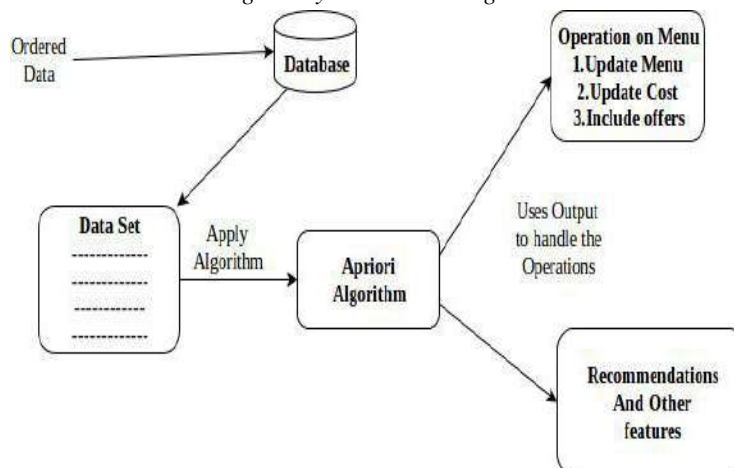


Fig 3.2 Admin Module

3.2 System flow analysis

The proposed system will be used by three types of users, mainly the customers, the kitchen or canteen staff and the administrator. Thus, the processes of the entire system can be divided into the three modules (as shown in fig 3.1) namely the admin module, the kitchen or canteen staff module and the customer module.

The food ordering management system will enable the customer to view the e-menu along with the recommendations, after viewing which, customers can place their order. Once the order is confirmed, bill will be generated along with a token.

The order data along with the token generated will be buffered and displayed onto the screen near the canteen staff. The canteen staff can view the order, prepare and serve it. The order details will be sent to the admin module for further processing.

From the above figure Fig 3.2 it can be seen that all the order details will act as an input to the Apriori algorithm and the output of the algorithm are the recommendations (as shown in fig 3.3) that are used for several purposes such as to determine most frequently ordered food item, update inventory and update menu.

IV. IMPLEMENTATION

We have developed a web-based application for our system. The implementation of the system is done using PHP, HTML, CSS, jQuery, Ajax, Bootstrap, JavaScript and the datasets are stored in MySQL database.

The hardware required for our application includes Android Smart phone and a desktop or laptop with browser and internet connection.

In our application Apriori plays an important role. We have considered six months order details of a canteen as an input to the Apriori algorithm and we obtain recommendations as shown in fig 4.1. The recommendations are the most frequently ordered food items, which the admin could use to update the menu and increase his profit.

Aitd Canteen

Home Food Items Order Details Analysis Recommendations

Inventory [Log out](#)

R. Id	Food Id	Food Name
504	2006	MON_Chole
505	2024	MON_Banana_Shake
506	2029	TUE_NonVeg_Fried_Rice
507	2032	TUE_Butterchicken
508	2035	TUE_Gobi_Mancharurian
509	2038	TUE_Chicken_Roll
510	2044	TUE_Bread
511	2045	TUE_Sprite
512	2061	WED_Biryani
513	2077	WED_Papaya_Shake
514	2087	THU_Chole
515	2098	THU_Bread
516	2109	FRI_Fried_Rice
517	2121	FRI_Chops
518	2137	SAT_NonVeg_fried_Rice
519	2138	SAT_Fish_Thali
520	2140	SAT_Butterchicken
521	2143	SAT_Gobi_Mancharurian
522	2154	SAT_Dew
523	2159	SAT_Banana_Shake
524	2001,2006	MON_Chole
525	2029,2032	TUE_NonVeg_Fried_Rice,TUE_Butterchicken
526	2061,2077	WED_Biryani,WED_Papaya_Shake

Fig. 4.1 GUI for viewing recommendations

V. CONCLUSION

Even though the existing system uses certain technologies in their food ordering system, the customer queue is not managed properly. The system proposed in this project eliminates most of the manual work and has no issues regarding customer queue, as the food is ordered online through web application. The proposed system eliminates calculation errors of bills and also provides many facilities to the admin module which includes all the required analysis of orders, profit values and stock. The proposed system uses Apriori algorithm for providing recommendation to the customers. This also makes the system more efficient as the admin has a clear idea about which food item was ordered the most. This will help him provide a better menu for the customer which will result in increase in profit. The future enhancement of the proposed system could be adding online payment system.

REFERENCES

[1] Morgan Kaufmann (2011), "Data Mining- Concepts and Techniques "3rd Edition, Jiawei Han, University of Illinois at Urbana-Champaign, Micheline Kamber, Jian Pei, Simon Fraser University.

[2] Ravinarayana A, Puja M C, Raghuvver K, information of science dept. NIE, Maysore-India,

International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper Using Clustered Database for **“Food Recommendation System”**, Volume 6, Issue 5, May 2016 ISSN: 2277 128X .

- [3] Kirti Bhandge, Tejas Shinde, Dheeraj Ingale, Neeraj Solanki, Reshma Totare , VDept. of Information Technology Engineering, AISSMS, Pune, **“A Proposed System for Touchpad Based Food Ordering System Using Android Application”**, Vol. 3, Issue 1 (Jan. - Mar. 2015) ISSN: 2347 - 8446 (Online) ISSN: 2347 - 9817 (Print).
- [4] Shabari B., Ashok Nayak, Pursuing M.Tech (ES), Working as Assistant Professor, Visvesvaraya College of Engineering and Technology (VCET), **“Zigbee based e-menu ordering system”**, Vol. 3, issue 08, August 2015, ISSN: 2348 -7550.
- [5] Aamir Nawaz, Faiz Jalil (2015) **“Touch Panel Based Modern Restaurants Automation using Zigbee Technology”** Institute of Engineering &Technology ,Gomal University, vol 3, issue 4, July 2015, ISSN 7164-0589.
- [6] Rani Kavade, Varsha Pansare, Pooja Kunjir, Ganesh Gavande March 2016, Volume 3, Issue3 **“ Proposed Automated Food Ordering System Using Data Mining Techniques”**Parvatibai Genba Moze College of Engineering, Pune, vol 3, issue 3, March 2016, ISSN 2349-5162.

Review, Analysis, and Classification of 3D Printing Literature: Types of Research and Technology Benefits

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Abstract— This paper presents a review, analysis and classification about 3D printing. Through the CAPES Sucupira platform, 124 articles with a high degree of relevance published between the years 2014 and 2018 were selected. Each of these articles was classified by means of 9 categories: study types, affiliation, approach, origin of the study, geographic scope, unit of analysis, scope, benefits and negative points. Through the results obtained, it was verified that the number of articles on 3D printing is increasing every year, which indicates its importance and popularity. Most of the time, scientific research is conducted and led by people connected to universities in Europe, Asia and the Americas. And finally, the number of citations related to the benefits of 3D printing are greater than the number of citations on the negative points of the process.

Keywords— 3D printing, additive manufacturing, literature review.

I. INTRODUCTION

The competition between companies of any industrial sector grows more and more each year. In this way, companies seek to reduce costs and deadlines and, at the same time, are pressured to develop and deliver products of high quality and performance. This competition generates the need to launch a new product in the market with a greater frequency and, consequently, the demand for new projects and development of new products grows. It is at this stage that 3D printing stands out (LOPES, 2016).

Popularly known as 3D printing, this process has many other names such as rapid prototyping (RP), additive manufacturing (AM) additive techniques, additive processes, among others (LOPES, 2016).

Within a few minutes or hours, this manufacturing process allows to produce complete products from a CAD software, using the most diverse raw materials and without a great human intervention. 3D printing has as its characteristic to construct three-dimensional pieces by means of the addition of successive thin layers, one on top of the other, until the formation of the desired product (ABREU, 2015; LOPES, 2016).

As mentioned earlier, additive manufacturing is an important technology in the development phase of the product. Its benefits are (LOPES, 2016): less time in the product development phase, lower costs, possibility of performing several tests and prototypes, increase product complexity without increasing deadline, decrease in

project delivery time.

1.1 Historic

The first known 3D printer was invented and patented by Charles W. Hull in 1986. In his patent he describes a method where it is possible to fabricate objects by solidifying layers of a photo polymer (resin). This process was called stereolithography (ABREU, 2015, AGUIAR, 2014).

Three years later, in 1989, Scott Crump patented another 3D printing equipment that uses a different method than the Charles Hull printer, called Fused Deposition Modelling (FDM). Through the ability to move along three axes, the nozzle of the printer deposits a molten material, and layer by layer the final object is produced. (AGUIAR, 2014).

However, the rapid prototyping process became better known and accessible in the early 2000s. With the expiration of FDM patents, Adrian Bowyer created the RepRap (Replicating Rapid Prototyper), where the software of the equipment is free, its source code is open and 57% of the mechanical 3D printer components are manufactured through the additive manufacturing process (concept of self-replicating machine). In this way, in 2004 the first low-cost 3D printer appeared (ABREU, 2015).

By having an open system, many people were interested in developing and enhancing Adrian Bowyer's original design, and thus, the 3D printer has become cheaper, more accessible and more efficient (ABREU, 2015).

1.2 Different Types of 3D Printing

Over the years, the evolution of technology has had a major impact on the development of other 3D printing processes. The following are the most applied processes.

1.2.1 Stereolithography (SLA)

As previously mentioned, stereolithography was the first 3D printing process created and, according to Abreu (2015), is the most used type of additive manufacture.

By means of the incidence of an ultraviolet laser, a layer of liquid resin is solidified. After this step, the platform where the solidified resin layer is located is moved slightly downward, causing a layer of liquid resin to be added. Again, the laser solidifies the resin creating a second layer. This process is repeated until the object is completely constructed (ABREU, 2015; LOPES, 2016; BIKAS et al., 2016).

1.2.2 Fused Deposition Modelling (FDM)

As explained earlier, the FDM process was the second type of additive manufacture created and is one of the most used processes because of its low cost.

In this process, thermoplastic filaments are heated in the extruder and deposited on the construction platform by means of the extrusion nozzle. The construction platform has a lower temperature than the deposited thermoplastic, causing it to solidify rapidly. The platform moves down, and the nozzle of the extruder deposits the second layer of material. This process is repeated until the object is created. (ABREU, 2015; LOPES, 2016; BIKAS et al., 2016).

1.2.3 3DP

Unlike the processes mentioned above, the 3DP uses as a raw material a ceramic powder and a liquid binding agent. In the first step, a layer of ceramic powder is evenly distributed on the building surface. Subsequently, the liquid binding agent is applied over the desired area by means of a jet. In the third step, a piston recedes, causing the object's construction surface to move downwards. Thereafter, a new layer of ceramic powder is added, followed by the liquid binder. This procedure is repeated until the piece reaches its final shape. The piece is removed from the machine and a jet of compressed air is applied in order to remove uncoated powder from the model. The prototypes manufactured using the 3DP method are fragile, and to make them more rigid it is necessary to subject them to a process of infiltration of resins (ABREU, 2015; BIKAS et al., 2016).

1.2.4 Selective Laser Sintering (SLS)

Like the 3DP process, selective laser sintering also uses a powder (usually thermoplastic, nylon or metal) as the raw material. This material is arranged in a homogeneous layer and a laser is applied to melt its particles, and thus solidify the material. This procedure is performed many times until the part is ready (LOPES, 2016; BIKAS et al., 2016).

1.2.5 Laminated Object Manufacturing (LOM)

This process can use different types of raw material, such as paper, plastic or metal. The material is laminated by a heated roller and glued to the bottom layer. Thereafter, it is cut by means of a laser (LOPES, 2016; BIKAS et al., 2016).

1.3 Steps of 3D Printing

To develop a project via 3D printing, you need to perform the following steps (AZEVEDO, 2013; OLIVEIRA, 2016):

- Develop a project of the desired object in 3D CAD software, such as SolidWorks, Inventor, AutoCAD, among others;
- Convert the project to STL (Standard Tecelation Language) format. This format describes surfaces of an object through a set of triangles of different dimensions. The more triangles there are, the greater the project accuracy;
- The next step is to choose a reference plane from the STL file, and so the object will be divided into layers parallel to the chosen reference plane. The smaller the size of the layer, the more accurate the print will be;
- Each of these layers is described by a file called GCODE. This code has the numerical commands for the manufacture of each of the layers, possessing information of temperature, trajectory, speed, positioning, among others;
- Finally, printing is done using the GCODE code, which directs the printer to obtain the desired object.

1.4 Application

Today, rapid prototyping has a very broad reach. It can be used in the most different industries, institutions of education from the fundamental level up to the higher level and for private use (individuals).

1.4.1 Aerospace Industry

It was one of the first areas to use the benefits of 3D printing to create prototypes quickly. The components of the aviation industry have a complex geometry and use advanced materials (advanced metal alloys such as:

titanium, nickel superalloys and special steels), which makes additive manufacturing a viable option (LOPES, 2016; BAHNINI et al.,2018).

1.4.2 Car Industry

The automotive industry was also one of the first to use 3D printing for the rapid development of prototypes / products and then began using the technology to manufacture the parts used in cars. Braking systems, drive shafts and gearbox parts are some examples of parts that are manufactured through additive manufacture (LOPES, 2016; BAHNINI et al.,2018).

1.4.3 Medicine and Dentistry

Like the two sectors mentioned above, the health area was also one of the first to use the technology. 3D printing is a great way to manufacture prostheses and implants, as these products require a high degree of customization due to the different morphological characteristics of each patient (LOPES, 2016; BAHNINI et al.,2018).

The next step in 3D printing that will revolutionize the medical world is 3D bioprinting, where the goal is to create bones, tissues and living organs (LOPES, 2016; BAHNINI et al.,2018).

1.4.4 Art and Fashion

Artistic class and fashion also surrendered to the benefits of 3D printing. Plastic artists have found an easier and more direct way of bringing their ideas to life, while fashion designers use technology to create a variety of different accessories, such as: luggage, shoes, glasses and hats (LOPES, 2016).

1.5 Objective

The objective of this work is to review, analyse and classify the research carried out on 3D printing between the years 2014 and 2018. Thus, it is expected to understand in what way the researches are being carried

out and what are the results achieved on the subject in recent years.

1.6 Justification

3D printing has great potential to positively impact manufacturing processes in the industrial sector. In this way, I believe that it is important that an analysis be done on the researches being carried out on the subject, showing their advances, benefits and points to be improved.

II. METHODOLOGY

This chapter presents the two methods used to perform this work: journal selection, which describes the criteria for choosing periodicals and articles used; and classification of articles, which explains the 9 categories created to classify the selected articles.

2.1 Journals Selection

Through the CAPES Sucupira platform, a first search was made about periodicals from Engineering III (which is composed of Mechanical, Production, Aerospace and Naval). The other criterion used in the search was the relevance index, where we searched for the best articles in this question (in this case, the best articles are classified with the indexes A1, A2, B1 or B2). In this way, 21 journals were selected that had articles on Production and Manufacturing Engineering.

Using the keywords "3d printing" and "Project", searches were carried out in the 21 selected journals from 2014 to 2018. Thus, articles were found in 8 newspapers.

After analysing the selected articles, it was verified that some of them contained only brief quotations on the subject of rapid prototyping and therefore were discarded. Thus, the final selection is shown in Table 1.

Table 1: Number of articles selected after review

REL.	Nº	JOURNAL	2014	2015	2016	2017	2018	TOTAL
	1	EUROPEAN JOURNAL OF OPERATIONAL RESEARCH		0	0	0	0	1
	2	INTERNATIONAL JOURNAL OF OPERATIONS & PRODUCTION MANAGEMENT		0	0	0	0	1
A1	3	INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS		1	1	0	2	7
	4	JOURNAL OF ENGINEERING DESIGN		0	0	1	1	2
	5	CONCURRENT ENGINEERING: RESEARCH AND APPLICATIONS		0	1	1	0	0

	6	INTERNATIONAL JOURNAL, ADVANCED MANUFACTURING TECHNOLOGY	2	5	14	19	26	66
B1	7	INTERNATIONAL JOURNAL OF COMPUTER INTEGRATED MANUFACTURING	0	0	0	1	4	5
	8	JOURNAL OF MANUFACTURING PROCESSES	1	4	5	9	15	34
	TOTAL		4	11	31	32	56	124

2.2 Articles Selection

The 124 selected articles were classified into 9 categories: study types, affiliation, approach, study origin, geographic coverage, unit of analysis, scope, benefits and negative points.

The category "types of study" refers to the way in which research is approached. Following the classification of Miguel (2007), the main types of research approach are:

- Conceptual theorist: new theories are developed through discussions of the existing literature;
- Case study: it is a more detailed analysis of one or more subjects or objects, aiming at their greater knowledge;
- Survey: Through a survey, you get information about a problem or object. Subsequently, an analysis of the collected data is made, in order to find a solution to the problem;
- Modelling and simulation: mathematical techniques or computer software are used to better understand a system;
- Action research: it is an empirical research where the researchers and interviewees seek to solve a given problem together;
- Literature review: study on a certain area of existing literature whose objective is to know and follow its development;
- Experimental research: it is the study about a system or object, where the researcher has control of one or more variables, manipulating them to observe what happens. The second category, "affiliation", aims to show what kind of institution is behind the research: university, research center or industry. The "approach" category analyses the data format used in the research: quantitative or qualitative. Next, the categories "origin of the study" and "geographic scope" are analysed, where they cover, respectively, in which continent the research was carried out and the scope of this study (regional, national or international). The sixth category is the "unit of analysis", where the area in which the study was carried out is classified:

Application in companies or academic projects in the areas of costs, design, production or product quality; study of theoretical model; social impact; equipment (hardware, software or process).

The seventh category, "scope", contemplates the subject studied by the article, while the last two categories classify the "benefits" and "negative points" found by the researchers.

In Annex I, you will find all the classifications mentioned above, as well as their captions. In Annex II, the classifications of the 124 analysed articles are detailed, according to the captions in the tables in Annex I.

III. RESULTS AND DISCUSSION

In this chapter the results obtained will be shown and analysed in the last section of the chapter. Firstly, the data of the publication numbers of the articles selected between the years 2014 and 2018 will be shown. After that, the data of each of the 9 categories mentioned in the methodology will be shown. In the final item, the results will be discussed.

3.1 Number of Article Publications about 3D Printing

Fig. 1 shows the percentage of articles published in the selected journals between the years 2014 and 2018. The small number of articles on rapid prototyping in the years 2014 and 2015 can be perceived, with the increase of these numbers in the following years, year of 2018, with 41.79% of articles released.

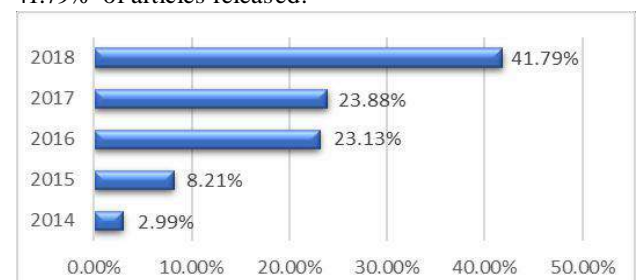


Fig. 1: Percentage distribution of articles published per year.

3.2 Types of Study

Fig. 2 shows the distribution of the types of studies performed. It was verified that the research study of the case was the most accomplished, with 61.3%. It is followed by far by experimental research, with 22.6%. Literature review, action research, modelling and simulation, survey and conceptual theorist obtained less than 10%, and action research was not performed once.

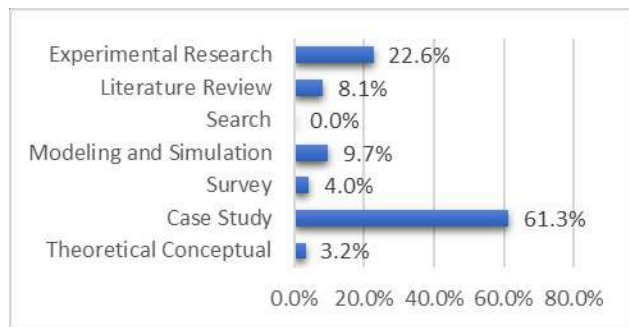


Fig. 2: Classification by type of study performed.

3.3 Affiliation

In order to carry out this classification, only the main author of each article was considered. Thus, although there were contributions from individuals linked to private industries and research centers, it was considered that 100% of the articles were carried out through universities, due to the fact that all the leaders of the articles are linked to institutions of teaching.

3.4 Approach

Fig. 3 shows the type of approach performed in the selected works, being it quantitative or qualitative. According to the figure below, 79.8% of the cases adopted are quantitative.

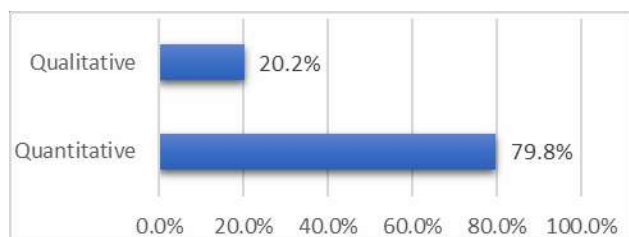


Fig. 3: Classification by approach.

3.5 Origin of Study

Fig. 4 classifies the origin of the articles. Asia and Europe lead the number of publications with 32.3% each. While the countries of the Americas (the only countries cited were the United States and Canada) published 25.8%. Oceania and Africa reached 4.8% and 2.4%, respectively, while Brazil also published 2.4% of the articles.

Even if the comparison between Brazil versus whole continents is somewhat unfair, the ideal would be that the number of relevant Brazilian research in the international scenario will grow in the coming years.

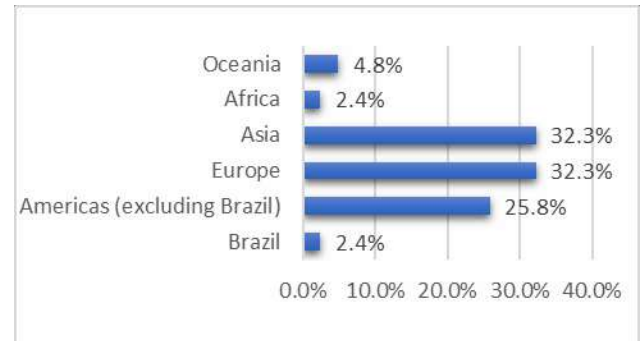


Fig. 4: Classification by origin

3.6 Geographical Scope

Fig. 5 classifies the articles by means of the geographical scope of the articles, that is, what territory was taken into account in their research (regional, national or international level). Only 11 of the 124 selected articles were found, and in 63.6% of these 11 articles, they were classified as international coverage and the other 36.6% as a national coverage.

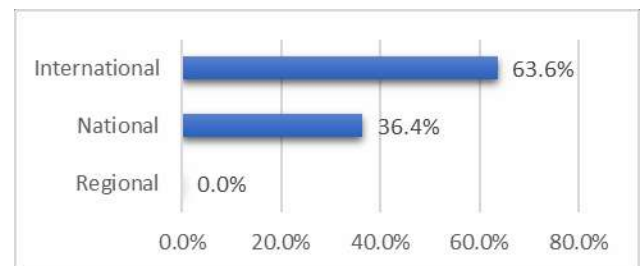


Fig. 5: Classification by geographic scope.

3.7 Unit of Analysis

Fig. 6 shows the unit of analysis data, that is, the area in which the search was performed. They were classified into 5 main groups, 4 of which have subgroups:

- Improvement in fast prototyping equipment (53.2%), being subdivided into process (33.1%), hardware (4.8%) and software (15.3%);
- Application in academic projects (37%), being subdivided into product quality (18.5%), production (11.3%), design (5.6%) and costs (1.6%);
- Application in companies (29.1%), being subdivided into product quality (3.2%), production (12.1%), design (6.5%) and costs (7.3%);
- Social Impact (1.6%), being subdivided into education (0%) and environmental (1.6%);
- Study of theoretical model (5.3%).

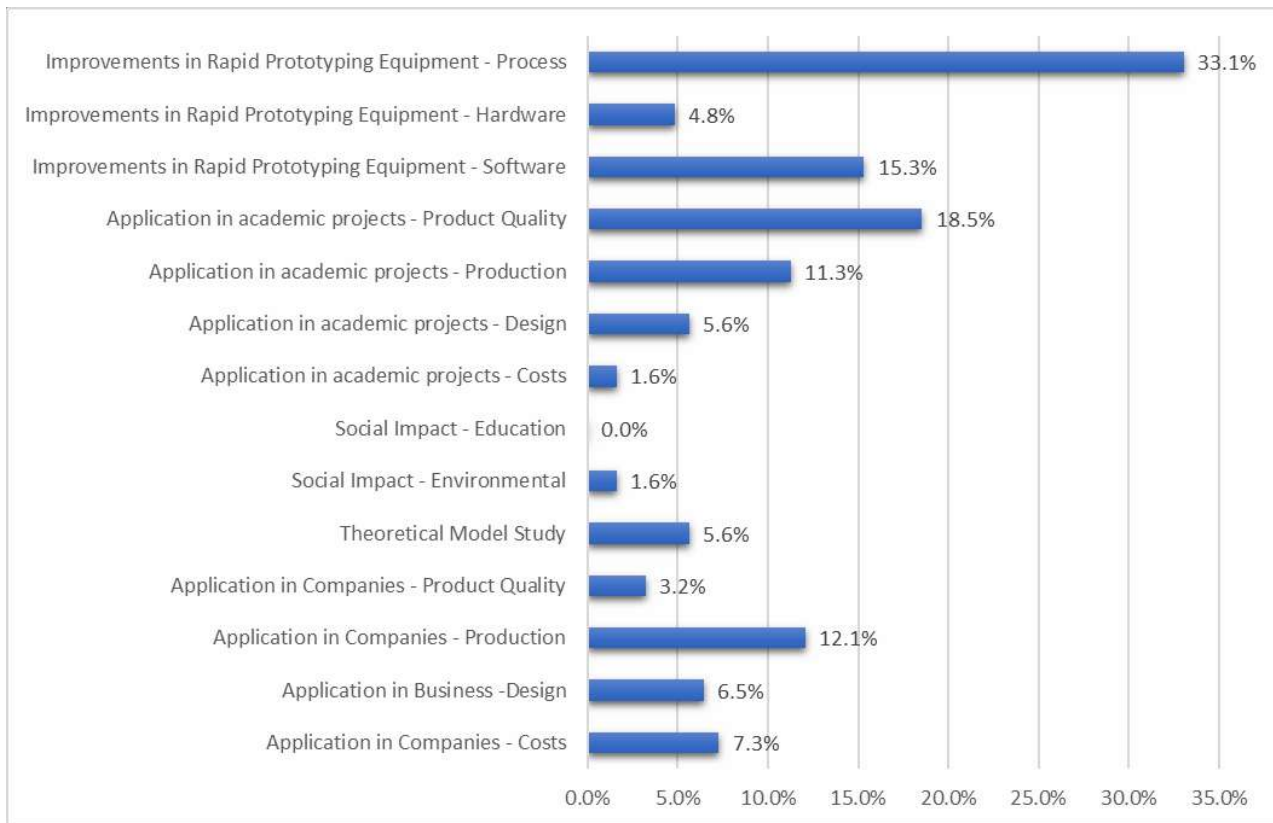


Fig. 6: Classification by unit of analysis.

3.8 Scope

Fig. 7 shows the scoped classification of articles. 62.1% of the articles refer to product development (it was considered as product development: manufacture of parts

via additive manufacture and improvements related to the "product" 3D printer), followed by a 21.8% impact of rapid prototyping and 12.1% to implementation strategies. The other items have less than 10%.

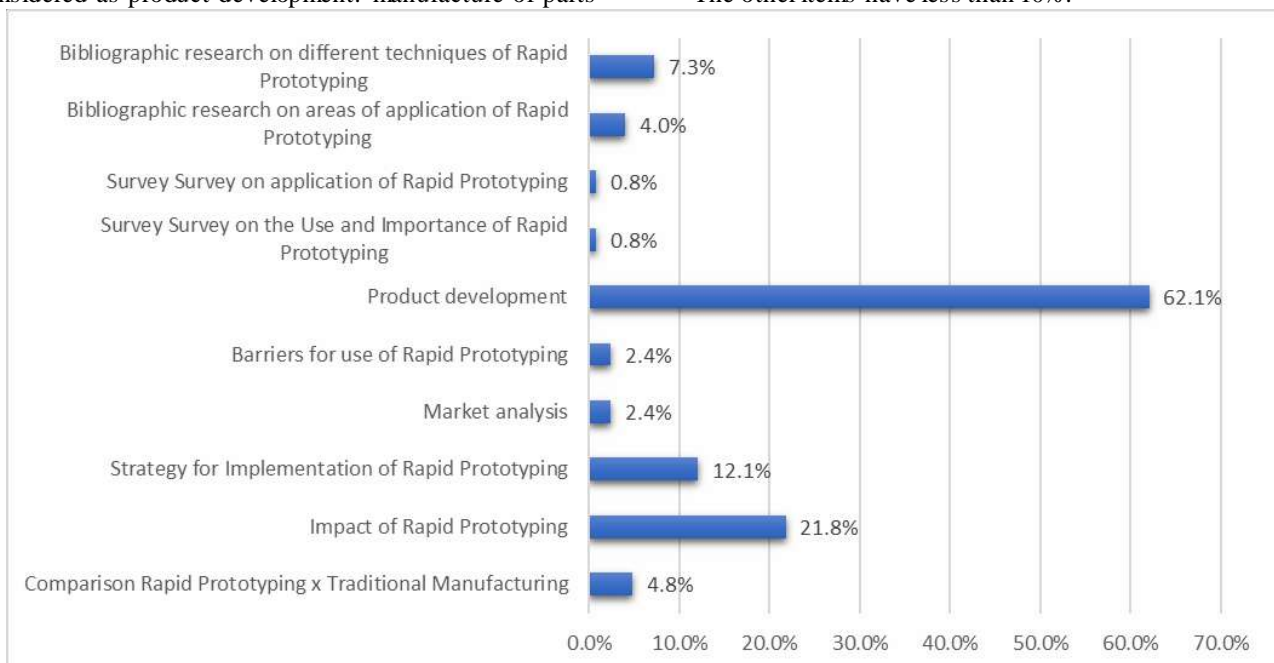


Fig. 7: Scope classification.

3.9 Benefits

Fig. 8 shows the benefits that rapid prototyping can provide. Of the 124 articles selected, 73 of them have verified one or more contributions. The contributions were classified into 8 different types, and the item "higher quality" appears in 38.7% of the articles. Improved

design, lead-time reduction and lower cost represent 16.9%, 14.5% and 12.1% respectively. The benefits of flexible manufacturing process, lower material waste, lower environmental impact and increased product life span appear with less than 5% each.

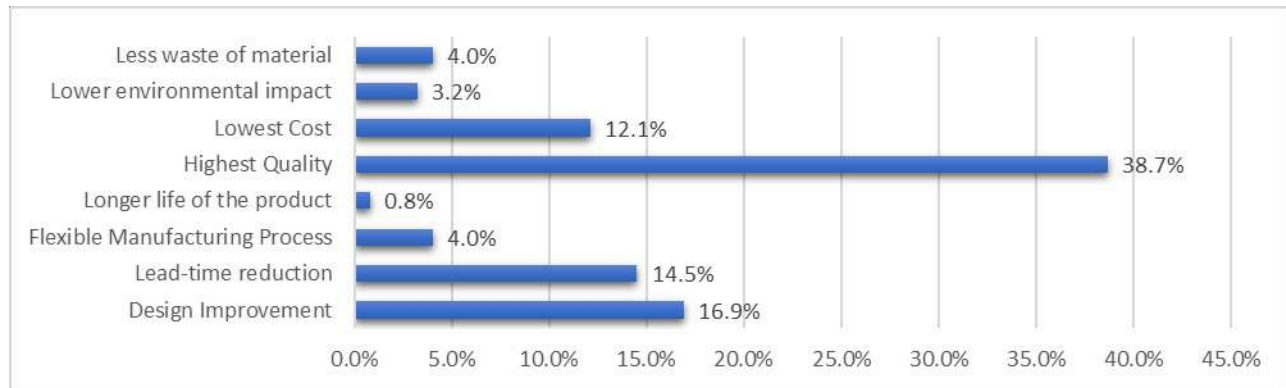


Fig. 8: Classification by benefits.

3.10 Pontos Negativos

Fig. 9 shows the negatives of rapid prototyping. Of the 124 articles selected, only 13 of them pointed out at least 1 item to improve. The highlights are the items higher

cost and difficulty of large-scale production, with 30.8% each and the items limited raw material and low reliability/quality of the product with 23.1% each.

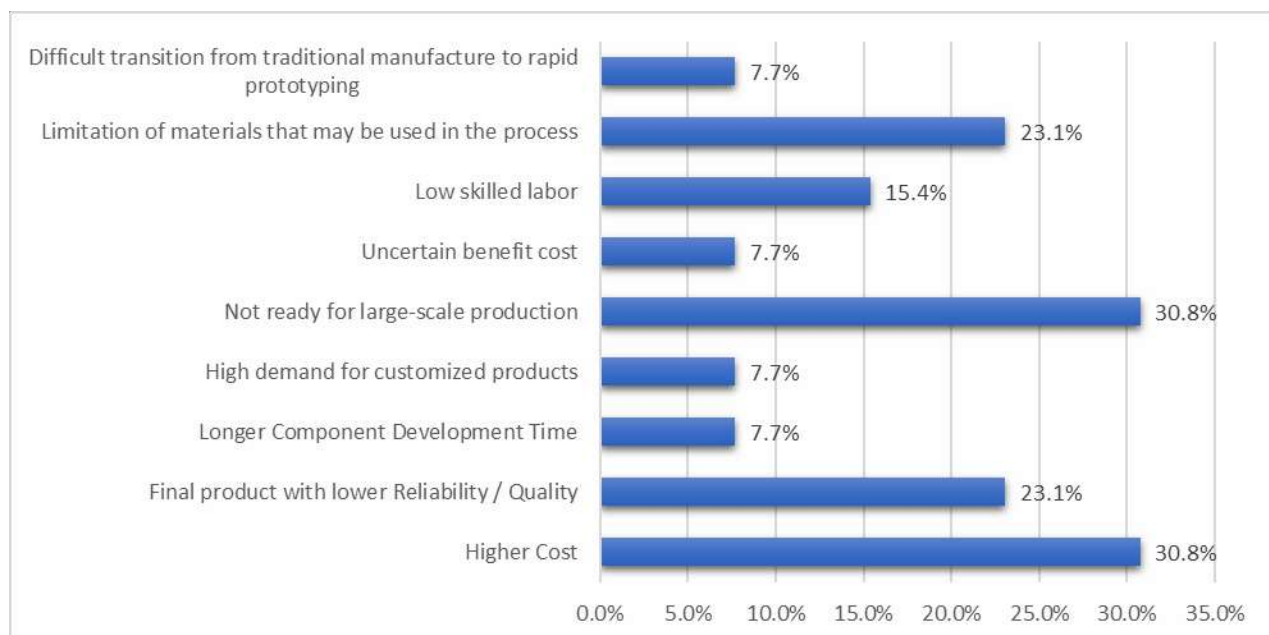


Fig. 9: Classification by negative points.

3.11 Data Analysis

Levando em consideração os dados apresentados nos itens anteriores pode-se dizer que:

1. The number of surveys with a high degree of relevance on 3D printing has been increasing year after year. This indicates that the theme's importance and

popularity have been growing and are seeking new ways to improve technology;

2. Although some studies are conducted exclusively for the purpose of studying the market or solving problems of private initiative, it is universities that conduct research in this area;

3. Europe and Asia are the continents that have published articles with a high degree of relevance about additive manufacturing;
4. Case study and experimental research were the two types of studies most performed within the analysed article sampling;
5. About 50% of articles aim to contribute to the improvement in 3D printing equipment (software, hardware or process), however, there are few articles related to the theme related to social impact;
6. 60% of the articles selected have as scope the development of a product;
7. Of the 124 papers analysed, 73 of them observed some benefit that 3D printing provided, being that higher quality, better design, reduction of lead-time and lower cost, were the qualities most cited. Meanwhile, only 13 articles mentioned some negative point regarding the additive manufacture, being lack of preparation for large- scale production and higher cost the two most cited damages.

IV. CONCLUSION

Through the data analysed, it can be concluded that 3D printing is increasingly being studied, which indicates the importance and popularity of the theme. Of the 124 articles selected, 2.99% of them were published in 2014, 8.21% in 2015, 23.13% in 2016, 23.88% in 2017 and 41.79% in 2018. Taking into account the category affiliation, all articles were classified as university students, that is, the research was led by professionals linked to higher education institutions. Taking into account the origin of the articles produced, it was verified that the majority are from Asia and Europe (32.2% produced in each continent, totalling 64.4%). Regarding the unit of analysis, the highlight was the improvement of equipment with a focus on process (33.1%) and, in article scope, the product development item was the most cited (62.1%). Finally, in the categories of benefits and negatives of 3D printing, the highlights were the higher quality of the product (38.7%) and higher cost and lack of capacity for high-scale production, with 30.8% for each of the items.

REFERENCES

- [1] ABREU, Sofia Alexandra Chaves. Impressão 3D Baixo Custo Versus Impressão em Equipamentos de Elevado Custo. 2015. 235 p. 2015. Dissertação (Mestrado Integrado em Engenharia Mecânica), Faculdade de Engenharia, Universidade do Porto, 2015.
- [2] AGUIAR, Leonardo de Conti Dias; YONEZAW, W. M. Construção de instrumentos didáticos com impressoras 3D. IV Simpósio Nacional de Ensino de Ciência e

Tecnologia (SINECT), Ponta Grossa, PR, Brasil, 2014.

- [3] ALABOODI, Abdulaziz S.; SIVASANKARAN, S. Experimental design and investigation on the mechanical behavior of novel 3D printed biocompatibility polycarbonate scaffolds for medical applications. *Journal of Manufacturing Processes*, v. 35, p. 479-491, 2018.
- [4] ALBERTI, E. A.; BUENO, B. M. P.; D'OLIVEIRA, A. S. C. M. Additive manufacturing using plasma transferred arc. *The International Journal of Advanced Manufacturing Technology*, v. 83, n. 9-12, p. 1861-1871, 2016.
- [5] ALLI, M Hazrat; MIR-NASIRI, Nazim; KO, Wai Lun. Multi-nozzle extrusion system for 3D printer and its control mechanism. *The International Journal of Advanced Manufacturing Technology*, v. 86, n. 1-4, p. 999-1010, 2016.
- [6] AREIR, Milad et al. A study of 3D printed active carbon electrode for the manufacture of electric double-layer capacitors. *Journal of Manufacturing Processes*, v. 25, p. 351-356, 2017.
- [7] ASADOLLAHI-YAZDI, Elnaz; GARDAN, Julien; LAFON, Pascal. Toward integrated design of additive manufacturing through a process development model and multi-objective optimization. *The International Journal of Advanced Manufacturing Technology*, v. 96, n. 9-12, p. 4145-4164, 2018.
- [8] AZEVEDO, Fábio Mariotto de. Estudo e projeto de melhoria em máquina de impressão 3D. 2013. 48f. Trabalho de Conclusão de Curso – Escola de Engenharia de São Carlos, Universidade de São Paulo, São Carlos, 2013.
- [9] BAHNINI, Insaf et al. Additive manufacturing technology: the status, applications, and prospects. *The International Journal of Advanced Manufacturing Technology*, p. 1-15, 2018.
- [10] BATURYNSKA, Ivanna. Statistical analysis of dimensional accuracy in additive manufacturing considering STL model properties. *The International Journal of Advanced Manufacturing Technology*, p. 1-15, 2018.
- [11] BAUMANN, Felix W.; KOPP, Oliver; ROLLER, Dieter. Abstract API for 3D printing hardware and software resources. *The International Journal of Advanced Manufacturing Technology*, v. 92, n. 1-4, p. 1519-1535, 2017.
- [12] BIKAS, H.; STAVROPOULOS, Panagiotis; CHRYSOLOURIS, George. Additive manufacturing methods and modelling approaches: a critical review. *The International Journal of Advanced Manufacturing Technology*, v. 83, n. 1-4, p. 389-405, 2016.
- [13] BONNARD, Renan et al. STEP-NC digital thread for additive manufacturing: data model, implementation and validation. *International Journal of Computer Integrated Manufacturing*, v. 31, n. 11, p. 1141-1160, 2018.

- [14] BOURNIAS-VAROTSIS, Alkaios et al. Ultrasonic Additive Manufacturing as a form-then-bond process for embedding electronic circuitry into a metal matrix. *Journal of Manufacturing Processes*, v. 32, p. 664-675, 2018.
- [15] BRANT, Anne; SUNDARAM, Murali M. A novel system for cloud-based micro additive manufacturing of metal structures. *Journal of Manufacturing Processes*, v. 20, p. 478-484, 2015.
- [16] BROOKS, Byron James et al. Robot-assisted 3D printing of biopolymer thin shells. *The International Journal of Advanced Manufacturing Technology*, v. 89, n. 1-4, p. 957-968, 2017.
- [17] BRUNA-ROSSO, Claire et al. Global sensitivity analyses of a selective laser melting finite element model: influential parameters identification. *The International Journal of Advanced Manufacturing Technology*, v. 99, n. 1-4, p. 833-843, 2018.
- [18] CAVIGGIOLI, Federico; UGHETTO, Elisa. A bibliometric analysis of the research dealing with the impact of Additive Manufacturing on industry, business and society. *International Journal of Production Economics*, 2018.
- [19] CHEKUROV, Sergei et al. The perceived value of additively manufactured digital spare parts in industry: An empirical investigation. *International Journal of Production Economics*, v. 205, p. 87-97, 2018.
- [20] CHAI, Yuan et al. Laser polishing of thermoplastics fabricated using fused deposition modelling. *The International Journal of Advanced Manufacturing Technology*, p. 1-8, 2018.
- [21] CHAN, Hing Kai et al. The impact of 3D Printing Technology on the supply chain: Manufacturing and legal perspectives. *International Journal of Production Economics*, v. 205, p. 156-162, 2018.
- [22] CHARRO, Alberto; SCHAEFER, Dirk. Cloud Manufacturing as a new type of Product-Service System. *International Journal of Computer Integrated Manufacturing*, v. 31, n. 10, p. 1018-1033, 2018.
- [23] CHEN, Lian et al. The research status and development trend of additive manufacturing technology. *The International Journal of Advanced Manufacturing Technology*, v. 89, n. 9-12, p. 3651-3660, 2017.
- [24] CHONG, Li; RAMAKRISHNA, Seeram; SINGH, Sunpreet. A review of digital manufacturing-based hybrid additive manufacturing processes. *The International Journal of Advanced Manufacturing Technology*, v. 95, n. 5-8, p. 2281-2300, 2018.
- [25] CORREA, Jorge E. et al. Laminated micro-machine: Design and fabrication of a flexure-based Delta robot. *Journal of Manufacturing Processes*, v. 24, p. 370-375, 2016.
- [26] DAWOUD, Michael; TAHA, Iman; EBEID, Samy J. Mechanical behaviour of ABS: An experimental study using FDM and injection moulding techniques. *Journal of Manufacturing Processes*, v. 21, p. 39-45, 2016.
- [27] DAWOUD, Michael; TAHA, Iman; EBEID, Samy J. Strain sensing behaviour of 3D printed carbon black filled ABS. *Journal of Manufacturing Processes*, v. 35, p. 337-342, 2018.
- [28] DE BLAS ROMERO, Adrián et al. Lithography- based additive manufacture of ceramic biodevices with design-controlled surface topographies. *The International Journal of Advanced Manufacturing Technology*, v. 88, n. 5-8, p. 1547-1555, 2017.
- [29] DU, Zhenglin et al. Investigation of porosity reduction, microstructure and mechanical properties for joining of selective laser melting fabricated aluminium composite via friction stir welding. *Journal of Manufacturing Processes*, v. 36, p. 33-43, 2018.
- [30] DUTY, Chad et al. What makes a material printable? A viscoelastic model for extrusion-based 3D printing of polymers. *Journal of Manufacturing Processes*, v. 35, p. 526-537, 2018.
- [31] ESPALIN, David et al. 3D Printing multifunctionality: structures with electronics. *The International Journal of Advanced Manufacturing Technology*, v. 72, n. 5-8, p. 963-978, 2014.
- [32] ESTELLE, Kevin et al. Manufacturing of smart composites with hyperelastic property gradients and shape memory using fused deposition. *Journal of Manufacturing Processes*, v. 28, p. 500-507, 2017.
- [33] EYERS, Daniel R. et al. The flexibility of industrial additive manufacturing systems. *International Journal of Operations & Production Management*, v. 38, n. 12, p. 2313-2343, 2018.
- [34] FANG, Xuewei et al. An investigation on effects of process parameters in fused-coating based metal additive manufacturing. *Journal of Manufacturing Processes*, v. 28, p. 383-389, 2017.
- [35] FENG, Qixiang et al. Quasi-static analysis of mechanical properties of Ti6Al4V lattice structures manufactured using selective laser melting. *The International Journal of Advanced Manufacturing Technology*, v. 94, n. 5-8, p. 2301-2313, 2018.
- [36] FERREIRA, Arno et al. Retrofitment, open-sourcing, and characterisation of a legacy fused deposition modelling system. *The International Journal of Advanced Manufacturing Technology*, v. 90, n. 9-12, p. 3357-3367, 2017.
- [37] GARG, Akhil et al. A comprehensive study in quantification of response characteristics of incremental sheet forming process. *The International Journal of Advanced Manufacturing Technology*, v. 89, n. 5-8, p. 1353-1365, 2017.
- [38] GHOBADIAN, Abby et al. Examining legitimatisation of additive manufacturing in the interplay between innovation, lean manufacturing and sustainability. *International Journal of Production Economics*, 2018.
- [39] GOH, Guo Liang et al. Additively manufactured multi-material free-form structure with printed electronics. *The International Journal of Advanced Manufacturing Technology*, v. 94, n. 1-4, p. 1309-

- 1316, 2018.
- [40] GUO, Liang; QIU, Jingxiong. Combination of cloud manufacturing and 3D printing: research progress and prospect. *The International Journal of Advanced Manufacturing Technology*, v. 96, n. 5-8, p. 1929-1942, 2018.
- [41] HABIB, Md Ahasan; KHODA, Bashir. Support grain architecture design for additive manufacturing. *Journal of Manufacturing Processes*, v. 29, p. 332-342, 2017.
- [42] HAN, Yiwei; WEI, Chuang; DONG, Jingyan. Droplet formation and settlement of phase-change ink in high resolution electrohydrodynamic (EHD) 3D printing. *Journal of Manufacturing Processes*, v. 20, p. 485-491, 2015.
- [43] HARTL, Richard F.; KORT, Peter M. Possible market entry of a firm with an additive manufacturing technology. *International Journal of Production Economics*, v. 194, p. 190-199, 2017.
- [44] HAWALDAR, Nishant; ZHANG, Jing. A comparative study of fabrication of sand casting mold using additive manufacturing and conventional process. *The International Journal of Advanced Manufacturing Technology*, v. 97, n. 1-4, p. 1037- 1045, 2018.
- [45] HELOU, Mark; KARA, Sami. Design, analysis and manufacturing of lattice structures: an overview. *International Journal of Computer Integrated Manufacturing*, v. 31, n. 3, p. 243-261, 2018.
- [46] HOLT, Nicholas et al. Microheater array powder sintering: A novel additive manufacturing process. *Journal of Manufacturing Processes*, v. 31, p. 536-551, 2018.
- [47] HSU, H. J. et al. Shrinkage prediction using finite element analysis and experimental validation using three-dimension slurry printing system. *The International Journal of Advanced Manufacturing Technology*, v. 91, n. 1-4, p. 1289-1296, 2017.
- [48] IMERI, A. et al. Fatigue analysis of the fiber reinforced additively manufactured objects. *The International Journal of Advanced Manufacturing Technology*, v. 98, n. 9-12, p. 2717-2724, 2018.
- [49] ISLAM, Mohammad Nazrul; GOMER, Hayden; SACKS, Samuel. Comparison of dimensional accuracies of stereolithography and powder binder printing. *The International Journal of Advanced Manufacturing Technology*, v. 88, n. 9-12, p. 3077-3087, 2017.
- [50] JABBARI, Amin; ABRINIA, Karen. Developing thixo-extrusion process for additive manufacturing of metals in semi-solid state. *Journal of Manufacturing Processes*, v. 35, p. 664-671, 2018.
- [51] JAISWAL, Prakhar; PATEL, Jayankumar; RAI, Rahul. Build orientation optimization for additive manufacturing of functionally graded material objects. *The International Journal of Advanced Manufacturing Technology*, p. 1-13, 2018.
- [52] JIANG, Zheng-Long et al. Multi-objective optimization of process parameters for biological 3D printing composite forming based on SNR and grey correlation degree. *The International Journal of Advanced Manufacturing Technology*, v. 80, n. 1-4, p. 549-554, 2015.
- [53] JIN, Jie; CHEN, Yong. Highly removable water support for Stereolithography. *Journal of Manufacturing Processes*, v. 28, p. 541-549, 2017.
- [54] JIN, Jie et al. A vibration-assisted method to reduce separation force for stereolithography. *Journal of Manufacturing Processes*, 2018.
- [55] JIN, Yuan; HE, Yong; DU, Jianke. A novel path planning methodology for extrusion-based additive manufacturing of thin-walled parts. *International Journal of Computer Integrated Manufacturing*, v. 30, n. 12, p. 1301-1315, 2017.
- [56] JIN, Yuan et al. An optimization approach for path planning of high-quality and uniform additive manufacturing. *The International Journal of Advanced Manufacturing Technology*, v. 92, n. 1-4, p. 651-662, 2017.
- [57] KAMATH, Chandrika. Data mining and statistical inference in selective laser melting. *The International Journal of Advanced Manufacturing Technology*, v. 86, n. 5-8, p. 1659-1677, 2016.
- [58] KANTAROS, Antreas; CHATZIDAI, Nikolaeta; KARALEKAS, Dimitris. 3D printing-assisted design of scaffold structures. *The International Journal of Advanced Manufacturing Technology*, v. 82, n. 1-4, p. 559-571, 2016.
- [59] KIM, Dong Sung Danny; TAI, Bruce L. Hydrostatic support-free fabrication of three-dimensional soft structures. *Journal of Manufacturing Processes*, v. 24, p. 391-396, 2016.
- [60] KITAYAMA, Satoshi et al. Numerical optimization of process parameters in plastic injection molding for minimizing weldlines and clamping force using conformal cooling channel. *Journal of Manufacturing Processes*, v. 32, p. 782-790, 2018.
- [61] KHODABAKHSHI, F.; GERLICH, A. P. Potentials and strategies of solid-state additive friction-stir manufacturing technology: A critical review. *Journal of Manufacturing Processes*, v. 36, p. 77-92, 2018.
- [62] KHORASANI, Amir Mahyar et al. A comprehensive study on surface quality in 5-axis milling of SLM Ti- 6Al-4V spherical components. *The International Journal of Advanced Manufacturing Technology*, v. 94, n. 9-12, p. 3765-3784, 2018.
- [63] KNOFIUS, Nils; VAN DER HEIJDEN, Matthijs C.; ZIJM, Willem HM. Consolidating spare parts for asset maintenance with additive manufacturing. *International journal of production economics*, v. 208, p. 269-280, 2019.
- [64] KUMAR, Narendra et al. The effect of process parameters on tensile behavior of 3D printed flexible parts of ethylene vinyl acetate (EVA). *Journal of Manufacturing Processes*, v. 35, p. 317-326, 2018.
- [65] KUMAR, Narendra et al. Investigation on the effects of

- process parameters in CNC assisted pellet based fused layer modeling process. *Journal of Manufacturing Processes*, v. 35, p. 428-436, 2018.
- [66] KUMAR, Sanjay. Process chain development for additive manufacturing of cemented carbide. *Journal of Manufacturing Processes*, v. 34, p. 121-130, 2018.
- [67] LAPLUME, Andre; ANZALONE, Gerald C.; PEARCE, Joshua M. Open-source, self-replicating 3-D printer factory for small-business manufacturing. *The International Journal of Advanced Manufacturing Technology*, v. 85, n. 1-4, p. 633-642, 2016.
- [68] LEAL, R. et al. Additive manufacturing tooling for the automotive industry. *The International Journal of Advanced Manufacturing Technology*, v. 92, n. 5-8, p. 1671-1676, 2017.
- [69] LEBEDEV, S. M. et al. Mechanical properties of PLA-based composites for fused deposition modeling technology. *The International Journal of Advanced Manufacturing Technology*, p. 1-8, 2018.
- [70] LEE, Y. S.; NANDWANA, Peeyush; ZHANG, Wei. Dynamic simulation of powder packing structure for powder bed additive manufacturing. *The International Journal of Advanced Manufacturing Technology*, v. 96, n. 1-4, p. 1507-1520, 2018.
- [71] LEI, Ningrong et al. An additive manufacturing process model for product family design. *Journal of Engineering Design*, v. 27, n. 11, p. 751-767, 2016.
- [72] LI, Dawei et al. Interior structural optimization based on the density-variable shape modeling of 3D printed objects. *The International Journal of Advanced Manufacturing Technology*, v. 83, n. 9-12, p. 1627-1635, 2016.
- [73] LI, Dawei et al. Self-supporting interior structures modeling for buoyancy optimization of computational fabrication. *The International Journal of Advanced Manufacturing Technology*, v. 95, n. 1-4, p. 825-834, 2018.
- [74] LI, Guiwei et al. Ultrasonic strengthening improves tensile mechanical performance of fused deposition modeling 3D printing. *The International Journal of Advanced Manufacturing Technology*, p. 1-9, 2018.
- [75] LI, Lin; HAGHIGHI, Azadeh; YANG, Yiran. A novel 6-axis hybrid additive-subtractive manufacturing process: Design and case studies. *Journal of Manufacturing Processes*, v. 33, p. 150-160, 2018.
- [76] LIU, Xinhua et al. Mechanical property parametric appraisal of fused deposition modeling parts based on the gray Taguchi method. *The International Journal of Advanced Manufacturing Technology*, v. 89, n. 5-8, p. 2387-2397, 2017.
- [77] LIU, Yang et al. Study on the influence of process parameters on the clearance feature in non-assembly mechanism manufactured by selective laser melting. *Journal of Manufacturing Processes*, v. 27, p. 98-107, 2017.
- [78] LOCKETT, Helen et al. Design for Wire+ Arc Additive Manufacture: design rules and build orientation selection. *Journal of Engineering Design*, v. 28, n. 7-9, p. 568-598, 2017.
- [79] LOPES, Gonçalo Teixeira Ferreira. Exploração das possibilidades da impressão 2D na construção. 2015-2016. 92 f. Dissertação (Mestrado em Engenharia Civil) – Faculdade de Engenharia, Universidade do Porto, Porto, 2016.
- [80] MACDONALD, Eric et al. Fabricating patch antennas within complex dielectric structures through multi-process 3D printing. *Journal of Manufacturing Processes*, v. 34, p. 197-203, 2018.
- [81] MAI, Jingeng et al. Customized production based on distributed 3D printing services in cloud manufacturing. *The International Journal of Advanced Manufacturing Technology*, v. 84, n. 1-4, p. 71-83, 2016.
- [82] MANÇANARES, Cauê G. et al. Additive manufacturing process selection based on parts' selection criteria. *The International Journal of Advanced Manufacturing Technology*, v. 80, n. 5-8, p. 1007-1014, 2015.
- [83] MANDIL, Guillaume et al. Building new entities from existing titanium part by electron beam melting: microstructures and mechanical properties. *The International Journal of Advanced Manufacturing Technology*, v. 85, n. 5-8, p. 1835-1846, 2016.
- [84] MAO, Huachao; ZHOU, Chi; CHEN, Yong. LISA: Linear immersed sweeping accumulation. *Journal of Manufacturing Processes*, v. 24, p. 406-415, 2016.
- [85] MAWALE, Mahesh B.; KUTHE, Abhaykumar M.; DAHAKE, Sandeep W. Additive layered manufacturing: State-of-the-art applications in product innovation. *Concurrent Engineering*, v. 24, n. 1, p. 94-102, 2016.
- [86] MELLOR, Stephen; HAO, Liang; ZHANG, David. Additive manufacturing: A framework for implementation. *International Journal of Production Economics*, v. 149, p. 194-201, 2014.
- [87] MIGUEL, Paulo Augusto Cauchick et al. Estudo de caso na engenharia de produção: estruturação e recomendações para sua condução. *Revista Produção*, v. 17, n. 1, p. 216-229, 2007.
- [88] MOHIUDDIN, Mohammed Viquar et al. Experimental investigation to produce thin-walled sand casting using combination of casting simulation and additive manufacturing techniques. *The International Journal of Advanced Manufacturing Technology*, v. 90, n. 9-12, p. 3147-3157, 2017.
- [89] MONZÓN, M. D. et al. Standardization in additive manufacturing: activities carried out by international organizations and projects. *The international journal of advanced manufacturing technology*, v. 76, n. 5-8, p. 1111-1121, 2015.
- [90] MUN, Jiwon et al. Indirect additive manufacturing based casting of a periodic 3D cellular metal-flow simulation of molten aluminum alloy. *Journal of Manufacturing Processes*, v. 17, p. 28-40, 2015.
- [91] MONZÓN, M. D. et al. 4D printing: processability and

- measurement of recovery force in shape memory polymers. The International Journal of Advanced Manufacturing Technology, v. 89, n. 5-8, p. 1827-1836, 2017.
- [92] OLIVEIRA, Leopoldo Gomes de. Produção de palmilhas ortopédicas em máquina de impressão 3D voltada para o mercado de corredores de rua. 2016. 93 f. Trabalho de Conclusão de Curso – Universidade Federal do ABC, Santo André, 2016.
- [93] PANDA, Biranchi N. et al. Performance evaluation of warping characteristic of fused deposition modelling process. The International Journal of Advanced Manufacturing Technology, v. 88, n. 5-8, p. 1799-1811, 2017.
- [94] PPAZETIS, G.; VOSNIAKOS, G.-C. Direct porous structure generation of tissue engineering scaffolds for layer-based additive manufacturing. The International Journal of Advanced Manufacturing Technology, v. 86, n. 1-4, p. 871-883, 2016.
- [95] PEREIRA, S.; VAZ, A. I. F.; VICENTE, L. N. On the optimal object orientation in additive manufacturing. The International Journal of Advanced Manufacturing Technology, p. 1-10, 2018.
- [96] PIRES, Liliana Sofia Oliveira; FERNANDES, Maria Helena Figueira Vaz; DE OLIVEIRA, José Martinho Marques. Biofabrication of glass scaffolds by 3D printing for tissue engineering. The International Journal of Advanced Manufacturing Technology, v. 98, n. 9-12, p. 2665-2676, 2018.
- [97] PRADEL, Patrick et al. Investigation of design for additive manufacturing in professional design practice. Journal of Engineering Design, v. 29, n. 4-5, p. 165-200, 2018.
- [98] PRADEL, Patrick et al. A framework for mapping design for additive manufacturing knowledge for industrial and product design. Journal of Engineering Design, v. 29, n. 6, p. 291-326, 2018.
- [99] PRIMO, Teresa et al. Additive manufacturing integration with topology optimization methodology for innovative product design. The International Journal of Advanced Manufacturing Technology, v. 93, n. 1-4, p. 467-479, 2017.
- [100] RAVI, Abinash Kurapatti; DESHPANDE, Anagh; HSU, Keng H. An in-process laser localized pre-deposition heating approach to inter-layer bond strengthening in extrusion based polymer additive manufacturing. Journal of Manufacturing Processes, v. 24, p. 179-185, 2016.
- [101] RAVN, Poul Martin; GUDLAUGSSON, Tómas Vignir; MORTENSEN, Niels Henrik. A multi-layered approach to product architecture modeling: Applied to technology prototypes. Concurrent Engineering, v. 24, n. 1, p. 3-16, 2016.
- [102] SALONITIS, Konstantinos. Design for additive manufacturing based on the axiomatic design method. The International Journal of Advanced Manufacturing Technology, v. 87, n. 1-4, p. 989-996, 2016.
- [103] SASAKI, Yuhi et al. Adaptive direct slicing of volumetric attribute data represented by trivariate B-spline functions. The International Journal of Advanced Manufacturing Technology, v. 91, n. 5-8, p. 1791-1807, 2017.
- [104] SCHNIEDERJANS, Dara G. Adoption of 3D-printing technologies in manufacturing: A survey analysis. International Journal of Production Economics, v. 183, p. 287-298, 2017.
- [105] SHANGGUAN, Haolong et al. 3D-printed rib-reinforced shell sand mold for aluminum castings. The International Journal of Advanced Manufacturing Technology, p. 1-8, 2018.
- [106] SHEYDAEIAN, Esmat; TOYSERKANI, Ehsan. A system for selectively encapsulating porogens inside the layers during additive manufacturing: From conceptual design to the first prototype. Journal of Manufacturing Processes, v. 26, p. 330-338, 2017.
- [107] SINGH, Sunpreet; RAMAKRISHNA, Seeram; SINGH, Rupinder. Material issues in additive manufacturing: A review. Journal of Manufacturing Processes, v. 25, p. 185-200, 2017.
- [108] SNELLING, Dean A. et al. Binder jetting advanced ceramics for metal-ceramic composite structures. The International Journal of Advanced Manufacturing Technology, v. 92, n. 1-4, p. 531-545, 2017.
- [109] SUNNY, SM Nahian Al; LIU, Xiaoqing F.; SHAHRIAR, Md Rakib. Communication method for manufacturing services in a cyber-physical manufacturing cloud. International Journal of Computer Integrated Manufacturing, v. 31, n. 7, p. 636-652, 2018.
- [110] TANG, Shiyan et al. Layered extrusion forming—a simple and green method for additive manufacturing ceramic core. The International Journal of Advanced Manufacturing Technology, v. 96, n. 9-12, p. 3809-3819, 2018.
- [111] TAVAKOLI, Mahmoud et al. Anthropomorphic finger for grasping applications: 3D printed endoskeleton in a soft skin. The International Journal of Advanced Manufacturing Technology, v. 91, n. 5- 8, p. 2607-2620, 2017.
- [112] THOMAS-SEALE, L. E. J. et al. The barriers to the progression of additive manufacture: Perspectives from UK industry. International Journal of Production Economics, v. 198, p. 104-118, 2018.
- [113] TRONVOLL, Sigmund A.; WELO, Torgeir; ELVERUM, Christer W. The effects of voids on structural properties of fused deposition modelled parts: a probabilistic approach. The International Journal of Advanced Manufacturing Technology, p. 1-12, 2018.
- [114] UPADHYAY, Meet; SIVARUPAN, Tharmalingam; EL MANSORI, Mohamed. 3D printing for rapid sand casting—A review. Journal of Manufacturing Processes, v. 29, p. 211-220, 2017.
- [115] URBANIC, R. J.; HEDRICK, R. W.; BURFORD, C. G. A

- process planning framework and virtual representation for bead-based additive manufacturing processes. The International Journal of Advanced Manufacturing Technology, v. 90, n. 1- 4, p. 361-376, 2017.
- [116] VIJAYARAGHAVAN, Venkatesh et al. Process characterisation of 3D-printed FDM components using improved evolutionary computational approach. The International Journal of Advanced Manufacturing Technology, v. 78, n. 5-8, p. 781-793, 2015.
- [117] WANG, Di et al. Surface quality of the curved overhanging structure manufactured from 316-L stainless steel by SLM. The International Journal of Advanced Manufacturing Technology, v. 86, n. 1-4, p. 781-792, 2016.
- [118] WANG, Jia-Chang; DOMMATI, Hitesh. Fabrication of zirconia ceramic parts by using solvent-based slurry stereolithography and sintering. The International Journal of Advanced Manufacturing Technology, v. 98, n. 5-8, p. 1537- 1546, 2018.
- [119] WEI, Chuang; DONG, Jingyan. Hybrid hierarchical fabrication of three-dimensional scaffolds. Journal of Manufacturing Processes, v. 16, n. 2, p. 257-263, 2014.
- [120] WELLER, Christian; KLEER, Robin; PILLER, Frank T. Economic implications of 3D printing: Market structure models in light of additive manufacturing revisited. International Journal of Production Economics, v. 164, p. 43-56, 2015.
- [121] WESTERWEEL, Bram; BASTEN, Rob JI; VAN HOUTUM, Geert-Jan. Traditional or Additive Manufacturing? Assessing component design options through lifecycle cost analysis. European Journal of Operational Research, 2018.
- [122] XIAO, Kaida et al. Developing a 3D colour image reproduction system for additive manufacturing of facial prostheses. The International Journal of Advanced Manufacturing Technology, v. 70, n. 9-12, p. 2043-2049, 2014.
- [123] YAMAN, Ulas. Shrinkage compensation of holes via shrinkage of interior structure in FDM process. The International Journal of Advanced Manufacturing Technology, v. 94, n. 5-8, p. 2187- 2197, 2018.
- [124] YANG, Sheng; ZHAO, Yaoyao Fiona. Additive manufacturing-enabled design theory and methodology: a critical review. The International Journal of Advanced Manufacturing Technology, v. 80, n. 1-4, p. 327-342, 2015.
- [125] YANG, Yang et al. 3D printing of shape memory polymer for functional part fabrication. The International Journal of Advanced Manufacturing Technology, v. 84, n. 9-12, p. 2079-2095, 2016.
- [126] YANG, Yiran; LI, Lin. Cost modeling and analysis for Mask Image Projection Stereolithography additive manufacturing: Simultaneous production with mixed geometries. International Journal of Production Economics, v. 206, p. 146-158, 2018.
- [127] YAO, Xifan; LIN, Yingzi. Emerging manufacturing paradigm shifts for the incoming industrial revolution. The International Journal of Advanced Manufacturing Technology, v. 85, n. 5-8, p. 1665-1676, 2016.
- [128] ZHANG, Hongyu et al. Development of a path planning algorithm for reduced dimension patch printing conductive pattern on surfaces. The International Journal of Advanced Manufacturing Technology, v. 95, n. 5-8, p. 1645-1654, 2018.
- [129] ZHA, Wentao; ANAND, Sam. Geometric approaches to input file modification for part quality improvement in additive manufacturing. Journal of Manufacturing Processes, v. 20, p. 465-477, 2015.
- [130] ZHAO, Gang et al. Nonplanar slicing and path generation methods for robotic additive manufacturing. The International Journal of Advanced Manufacturing Technology, v. 96, n. 9-12, p. 3149-3159, 2018.

ANNEX I: Classification Tables for Articles

Table 1: Articles classification by types of study.

LABEL	T1 : Types of Study
A	Theoretical Conceptual
B	Case Study
C	Survey
D	Modeling and Simulation
E	Search
F	Literature Review
G	Experimental Research

Table 2: Articles classification by affiliation.

LABEL	T2: Affiliation
U	University
CP	Research Center
EP	Company

Table 3: Articles classification by approach.

LABEL	T3: Approach
A	Quantitative
B	Qualitative

Table 4: Articles classification by study origin.

LABEL	T4: Origin
BR	Brazil
AM	Americas (excluding Brazil)
EU	Europe
AS	Asia
AF	Africa
OC	Oceania

Table 5: Articles classification by geographical scope of the study.

LABEL	T5: Geographical scope of study
RE	Regional
NA	National
IN	International

Table 6: Articles classification by unit of analysis.

LABEL	T6: Analysis Unit
EC	Application in Companies - Costs
ED	Application in Business -Design
EP	Application in Companies - Production
EQ	Application in Companies - Product Quality
MT	Theoretical Model Study
ISA	Social Impact - Environmental

ISE	Social Impact - Education
UC	Application in academic projects - Costs
UD	Application in academic projects - Design
UP	Application in academic projects - Production
UQ	Application in academic projects - Product Quality
MS	Improvements in Rapid Prototyping Equipment - Software
MH	Improvements in Rapid Prototyping Equipment - Hardware
MP	Improvements in Rapid Prototyping Equipment - Process

Table 7: Articles classification by scope.

LABEL	T7: Scope of the article
A1	Comparison Rapid Prototyping x Traditional Manufacturing
A2	Impact of Rapid Prototyping
A3	Strategy for Implementation of Rapid Prototyping
A4	Market analysis
A5	Barriers for use of Rapid Prototyping
A6	Product development
A7	Survey Survey on the Use and Importance of Rapid Prototyping
A8	Survey Survey on application of Rapid Prototyping
A9	Bibliographic research on areas of application of Rapid Prototyping
A10	Bibliographic research on different techniques of Rapid Prototyping

Table 8: Articles classification by benefits.

LEGENDA	T8: Benefits
B1	Design Improvement
B2	Lead-time reduction
B3	Flexible Manufacturing Process
B4	Longer life of the product
B5	Highest Quality
B6	Lowest Cost
B7	Lower environmental impact
B8	Less waste of material

Table 9: Articles classification by negative points.

LEGENDA	T9: Negative points
C1	Higher Cost
C2	Final product with lower Reliability / Quality
C3	Longer Component Development Time
C4	High demand for customized products
C5	Not ready for large-scale production
C6	Uncertain benefit cost
C7	Low skilled labor
C8	Limitation of materials that may be used in the process
C9	Difficult transition from traditional manufacture to rapid prototyping

ANNEX II: Selected Articles Classification

Table 1: Classification of articles by type of study.

Journal	Authors	T1	T2	T3	T4	T5	T6	T7	T8	T9
1	Westerweel et al. (2018)	B	U	A	EU	IN	EC,ED,EQ	A1	B1,B2	C1,C2
2	Eyers et al. (2018)	B	U	B	EU	IN	EP	A2	B3	
3	Melor et al. (2014)	B	U	B	EU	IN	EP	A3	B2,B4	C3
3	Weller et al. (2015)	A,F	U	B	EU		MT	A2	B1,B2,B3	C4
3	Schniederjans (2017)	C	U	A	AM	NA	EC,ED,EP	A7	B2,B5	
3	Hartl & Kort (2017)	B	U	A	EU		MT	A4		
3	Chan et al. (2018)	C	U	B	AS	IN	EC,ED,EP	A8		C5
3	Thomas-Seale et al. (2018)	B,C	U	A	EU	NA	EC	A4, A5		C2,C5,C6, C7,C8
3	Ghobadian et al. (2018)	B	U	B	EU		EC,ISA	A2	B6,B7,B8	C5
3	Chekurov et al. (2018)	C	U	B	EU	NA	ED,EP,EQ	A3	B1,B2,B5,B6	
3	Knofius et al. (2018)	B	U	A	EU		ED,EP,EQ,EP	A3	B2,B5,B6	C9
3	Caviggioli & Ughetto (2018)	F	U	A	EU	IN	EC,ISA	A9		
3	Yang & Lin (2018)	D	U	A	AM		MT	A2	B1,B6	
4	Lei et al. (2016)	B	U	A	AS		UQ	A1, A2	B1	
4	Lockett et al. (2017)	B	U	A	EU		UQ	A2	B1,B8	
4	Pradel et al. (Jun, 2018)	B	U	B	EU		ED	A9		
4	Pradel et al. (Mar, 2018)	C	U	B	EU	IN	ED	A2	B1	C1
5	Ravn et al. (2015)	D	U	B	EU	NA	MS	A2	B1	
5	Mawale et al. (2016)	B	U	B	AS		EC,ED,EQ	A2	B1,B5,B6	
6	Xiao et al. (2014)	B,D,G	U	A	EU		UQ,UD,UC	A2,A6	B1,B2,B5,B6	

6	Espalin et al. (2014)	B,G	U	A	AM		UQ,UP	A2,A6	B1	
6	Monzón et al. (2015)	B	U	B	EU		EP	A3,A5		C7,C8
6	Vijayaraghavan et al. (2015)	D	U	A	AS		MS	A2	B1,B5	
6	Jiang et al. (2015)	D,G	U	A	AS		MP	A2,A6	B5	
6	Mançaneres et al. (2015)	B	U	A	BR		UQ	A2,A6		
6	Yang & Zhao (2015)	A	U	B	AM		MT	A2,A6		
6	Kantaros et al. (2016)	G	U	A	EU		MH	A6	B5	
6	Bikas et al. (2016)	F	U	B	EU		MT	A10		
6	Mai et al. (2016)	B	U	B	AS		EP	A2	B2,B3,B6,B7	
6	Li et al. (2016)	A	U	A	AS		UQ	A6	B5	
6	Alberti et al. (2016)	G	U	A	BR		MP	A2	B5	
6	Yang & Lin (2016)	G	U	A	AS		MP, UQ	A2,A6	B5	
6	Yao & Lin (2016)	B	U	B	AS		EP	A3	B3	
6	Laplume et al. (2016)	B	U	A	AM		EC, EP	A4		
6	Mandil et al. (2016)	B	U	A	EU		MP	A2	B5	
6	Ali et al. (2016)	G	U	A	AS		MH, MP	A2	B6	C5
6	Wang et al. (Set,2016)	B	U	A	AS		UQ	A6	B5	
6	Papazetis & Vosniakos (2016)	B	U	A	EU		UQ	A6	B5	
6	Kamath (2016)	G	U	A	AM		MS	A2	B5	
6	Salonitis (2016)	B	U	B	EU		UD	A3		
6	Islam et al. (2017)	B	U	A	OC		UQ	A10		
6	Romero et al. (2017)	B	U	B	EU		MP	A2,A6		
6	Panda et al. (2017)	B	U	A	EU		UQ	A10		
6	Brooks et al.	G	U	A	OC		MP	A2,A6		

	(2017)								
6	Monzón et al. (2017)	G	U	A	EU		MP	A2,A6	B1,B5
6	Liu et al. (2017)	G	U	A	AS		MP	A2,A6	B5
6	Garg et al. (2017)	G	U	A	AS		MP	A2,A6	B5
6	Chen et al. (2017)	B	U	B	AS		EP	A3,A5	C1,C8
6	Urbanic et al. (2017)	B	U	A	AM		EP	A3	
6	Ferreira et al. (2017)	G	U	A	OC		MS, MH	A6	B5
6	Mohiuddin et al. (2017)	B,D	U	A	AS		UQ	A6	B5
6	Tavakoli et al. (2017)	B	U	A	EU		UD	A6	B5
6	Hsu et al. (2017)	B,D	U	A	AS		UP, UQ	A6	B5,B6
6	Sasaki et al. (2017)	D	U	A	AS		MS	A6	
6	Baumann et al. (2017)	B	U	B	EU		UP	A3	
6	Snelling et al. (2017)	B	U	A	AM		MP	A6	B5
6	Leal et al. (2017)	B	U	A	EU	IN	EP,EC	A1,A3,A6	B2,B6
6	Jin et al. (2017)	B	U	A	AS		MS	A6	B1
6	Primo et al. (2017)	B	U	A	EU		UD,UP	A6	B5
6	Goh et al. (2018)	B	U	A	AS		UQ	A10	B5
6	Yaman (2018)	B	U	A	EU		MS,MP	A6	B5,B8
6	Feng et al. (2018)	B	U	A	AS		UP	A6	B1,B6
6	Khorasani et al. (2018)	B	U	A	OC		UD,UP	A6	B1
6	Li et al. (Mar, 2018)	B	U	A	AS		MS,MP	A6	B1,B5
6	Chong et al. (2018)	F	U	B	AS		UD,UP	A10	
6	Zhang et al. (Mar, 2018)	B	U	A	AS		MS	A6	B2
6	Lee et al. (2018)	D	U	A	AM		MP	A6	
6	Jaiswal et al.	B	U	A	AM		MS	A6	B2

	(2018)								
6	Li et al. (May, 2018)	G	U	A	AS		MP	A6	B5
6	Guo & Qiu (May, 2018)	F	U	B	AS		UP	A3	
6	Shangguan et al. (2018)	G	U	A	AS		MP	A6	B2,B5
6	Zhao et al. (2018)	B,D	U	A	AS		MS	A6	B2
6	Chai et al. (2018)	B	U	A	OC		UC,UP,UQ	A6	B2, B5, B6
6	Asadollahi-Yazdi et al. (2018)	B	U	A	EU		UP	A3,A6	
6	Tang et al. (2018)	G	U	A	AS		MP	A6	B5,B7
6	Hawaldar et al. (2018)	B	U	A	AM		UQ	A1	B2,B5,B8
6	Bahnini et al. (2018)	F	U	B	AF		EP	A1,A2,A9,A10	
6	Lebedev et al. (2018)	B	U	A	EU		MS	A6	B5
6	Baturynska (2018)	D	U	A	EU		UQ	A6	C1
6	Tronvoll et al. (2018)	B	U	A	EU		MS, UQ	A6	B5
6	Pereira et al. (2018)	B	U	A	EU		MS, UQ	A6	B5
6	Wang & Dommati (Set, 2018)	G	U	A	AS		MP	A6	B5
6	Pires et al. (2018)	G	U	A	EU		MP	A6	B5
6	Bruna-Rosso et al. (2018)	G	U	A	EU		MP	A6	B5
6	Imeri et al. (2018)	B	U	A	AM		UQ	A6	
7	Jin et al. (2017)	B	U	A	AS		MS	A6	B1,B2,B5
7	Sunny et al. (2018)	B	U	B	AM		UP	A3	
7	Helou & Kara (2018)	F	U	B	OC		UD,UP	A9	
7	Charro & Schaefer (2018)	B	U	A	EU		MP	A3	B3, B6
7	Bonnard et al. (2018)	A	U	A	BR		MS	A6	

8	Wei & Dong (2014)	B	U	A	AM		MS	A6	B5
8	Han et al. (2015)	B	U	A	AM		MP	A6	
8	Mun et al. (2015)	D	U	A	AS		MP	A6	
8	Brant & Sundaram (2015)	B	U	A	AM		MP	A3	B2
8	Zha & Anand (2015)	B	U	A	AM		MS	A6	B1,B5
8	Ravi et al. (2016)	B	U	A	AM		MP	A6	B5
8	Dawoud et al. (2016)	B	U	A	AF		UQ	A1	C2
8	Kim & Tai (2016)	B	U	A	AM		MP	A6	
8	Correa et al. (2016)	B	U	A	AM		MH	A6	
8	Mao et al. (2016)	B	U	A	AM		MP	A6	B1,B5
8	Habib & Khoda (2017)	B	U	A	AM		MP	A6	B1,B2,B5
8	Upadhyay et al. (2017)	F	U	A	EU		UP	A10	
8	Jin & Chen (2017)	B	U	A	AM		MH	A6	
8	Fang et al. (2017)	B	U	A	AS		MP	A6	B6
8	Estelle et al. (2017)	B	U	A	AM		MP	A6	B5
8	Liu et al. (2017)	B	U	A	AS		MH	A6	B5
8	Sheydaeian & Toyserkani (2017)	B,G	U	A	AM		MP	A6	
8	Areir et al. (2017)	B	U	A	EU		MP	A6	
8	Singh et al. (2017)	F	U	B	AS		MT	A9,A10	
8	Khodabakhshi & Gerlich (2018)	F	U	A	AM		MT	A10	
8	Du et al. (2018)	B	U	A	AS		MP	A6	
8	Alaboodi & Sivasankaran (2018)	B	U	A	AS		MP	A6	B5
8	Kumar et al. (2018)	B	U	A	AS		MH	A6	B5

8	Kumar et al. (2018)	B	U	A	AS		UQ	A6	
8	Dawoud et al. (2018)	B	U	A	AF		UQ	A6	

8	Jabbari & Abrinia (2018)	B,G	U	A	AS		MP	A6		
8	Duty et al. (2018)	B	U	A	AM		MP	A6		
8	Jin et al. (2018)	G	U	A	AM		MP	A6		
8	Kumar (2018)	G	U	A	AM		MP	A6		
8	MacDonald et al. (2018)	G	U	A	AM		UP	A6		
8	Li et al. (2018)	G	U	A	AM		MP	A6	B6,B7,B8	
8	Kitayama et al. (2018)	G	U	A	AS		MS	A6		
8	Bournias-Varotsis et al. (2018)	G	U	A	EU		MP	A6		
8	Holt et al. (2018)	G	U	A	AM		MP	A6		

Application of the Queue theory in the Optimization of systems of attendance in the ice Cream Shop in the city of Manaus-AM-Brazil

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Abstract— A queues through investigations of probability distributions generated and directed to the flow of customers and services to meet the demand of new customers waiting time in queues through practical ways. This work had as objective, a real reduction in the service queue of an ice cream shop. They were selected according to the specific needs of the optimization of processes, eliminating bottlenecks and processes. Some services have taken into account the peculiarities of the place, and public, having been receiving quality services and financially for the clients.

Keywords— *Theory of Queues, Process optimization, probability.*

I. INTRODUCTION

Queues are integrated into our lives, we come across them every day, they are easily found everywhere we go. Whether it's a simple trip to a supermarket, or even the time to pay for the products purchased, we will participate in queues. Queues are also visible in the production process, either awaiting the raw material to forge a particular part, or in the production line waiting for the previous processes to continue production.

Queuing theory and a mathematical subdivision of probability, which studies the creation of queues through mathematical formulations, is possible to calculate the beginning of the queue and even the sizes that will reach in the future, through existing models and mathematical formulas, it is possible to size this information so that an ideal layout can be created to meet the necessary demands of the queues.

Because the ice cream shop is a direct customer service, it has to address the employee to request the service desired, create temporary queues that directly affect the waiting time of the same, adversely affecting the process of the service to be offered; the agility in the queues appeals directly to customers, due to the fact that they expect less, waiting for that and for them time lost since it does not add anything to the process of acquiring your product.

Through data collection at peak times, it is possible to identify the main negative factors that contribute to the formation and development of the queues, with this data at hand and possible to work on effective solutions to solve the problems identified, using the numerical data of

times of queuing, customer service, and if it is possible to perceive the temporal deficit that is in the service flow, using the tools of queuing theory makes it possible to identify the data that will be necessary to supply the demand of identifying the total number of queues required and the ideal time to take the activity.

II. LITERATURE REVIEW

Even with all technological advances, companies that provide direct customer service will not be able to get out of the queues, the congestion of customers in queues for the purchase of products or services, be it invoice payments, internet or bank services, or until the use of equipment, for example a printer of papers, and a daily problem that the administration must handle, the waiting time in a queue reflects directly in the quality of the service of a certain establishment being directly connected the quality of the service offered.

The ice cream shop has a model of direct customer service, that is, all the service offered and requested to the responsible official, after the request is made the same, goes to prepare the service that was requested, that time between the request and the the queue is formed during the flow of processes, queues that do not add benefit to the process, and only cause customer dissatisfaction. The ice cream shop has a model of direct customer service, that is, all the service offered and asked the responsible official, after the request is made the same, goes to prepare the service that has been requested, this time between the request and the conclusion of the service, creates if a lead time, due to the attendance system if by

single queue, and the arrival rate is higher than the attendance rate, form the queue in the course of the flow of processes, queues that do not add benefit to the process, causing dissatisfaction to customers.

2.1 QUEUING THEORY

The queuing theory is a technical and mathematical concept that aims to minimize the queues that form in the process and services lines, through determined theories and formulas, if it is possible to realign them, consequently the correction of lost time in the waiting of the process of attendance.

According to [1], it is noticed that the waiting, in general, sensitize the client in its future behavior. A consumer dissatisfied with his waiting time may be able to give up his purchase at that time, however, he may no longer return to that establishment because of the perceived negative image. This is a difficult loss to be quantified, and if the problem persists for a long time the establishment will drop demand without discovering the reason of it.

When offering a product, it is offering a range of service, the time to complete the service is one of the most important factors, due to affect directly in the customer experience, leaving to positive or negative memory.

However, queuing theory is not only applied to people, in industries this fact often occurs, parts and products can wait for processing. As well ships may be waiting to enter the ports, and airplanes may be awaiting authorization to land [2].

According to [3], a queuing system is composed of many elements that are waiting to be serviced at a service station and that should wait until the station is available. According to [4], in the characterization of a queuing system, it is possible to highlight five basic components, the model of arrivals of the users, the service model, the number of available channels, the capacity for user service and the discipline of queue.

All queues follow parameters that can be measured which are them: clients, quantity of clients in the process; Average number of clients in queue (L_f) and arrival rate (λ); execution of care; limit of resources, be they equipment, helpers, among others; frequency of the queue; Number of service channels, average number of customers in queue (L_f); Average number of customers in the system (L); Average time the client waits in queue (W_f), average time that the client waits on the system (W).

The form of customer arrivals in a system occurs, most often at random, ie the number of customers arriving per unit time varies according to the behavior of the arrivals flow. For this, it is important to make a statistical

survey in order to verify the arrival process of the clients [3], [5].

2.2 MODEL OF SERVICE

Queue systems have varying structures, and each case requires a different analytical study. The structures can be classified as a single-queue and one-channel system, a single-queue system and multiple channels, and a complex system of queues and channels in series and in parallel [6].

The system of a queue is the simplest case of service queue, consisting of only one channel and a single queue, figure 1.

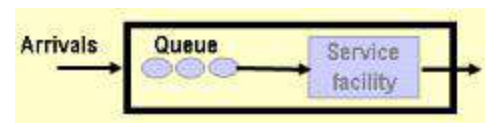


Fig.1: System single-queue and one-channel.

Source: [6].

The multi-channel system consists of multiple attendants for a single queue, thus facilitating service flow, Figure 2.

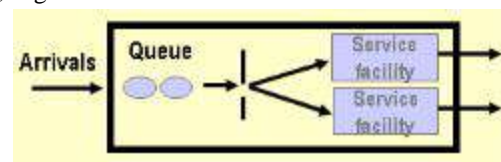


Fig.2: One queue and more than one channel.

Source:[7].

Single queues with 1 channel are the simplest and the most common ones, due to being the simplest and easiest applicable principle, however, depending on the demand in which the queue is fed, this concept must be rethought and reanalyzed in order to suppress the and provided in the queue by changing the channel quantity if it was possible to suppress the demand due to the increase in system finishing capacity.

2.3 LAYOUT

The layout also referred to as physical arrangement [8], is a graphical demonstration of the production system, although it seems to be only a system design, layout is more than that, it is a technique used to identify the locations to distribute properly the physical components of the production area, in order to organize the components in their proper places, in order to obtain the maximum possible efficiency in the production.

In order to establish exactly the layout of the production process, it is necessary to consider the location of the equipment and the employees, always aiming to be as close as possible to the process, without ignoring the process flow and the safety areas [9].

According to [8], the 3 main types of layout are: Layout by product or linear in which the product moves between the machines and the workstations, which remain

fixed. It is applicable on assembly lines. Process or functional layout is applied, for example, when products with different production flows are manufactured involving them. Fixed or positional layout in which the product remains fixed in place while machines and personnel move by performing the production tasks. This is the case of the manufacture of a ship.

An irregular layout with failures leads to a longer lead time [10], which can be improved with the alignment of the activity flow, shorter distance between equipment, less time in the process flow, which directly influences the service offered, due to the agility to carry out the process, directly influencing the reduction of queues, and customer satisfaction.

2.4 Ishikawa diagram

Known as a cause and effect diagram because it demonstrates the relationship between the possible and effects and their causes, facilitating the understanding of the problem, also known popularly as a fishbone due to its shape, the more detailed the diagram is more like a fishbone

To build the Ishikawa you must follow some steps:

- Describe the problem to be analyzed.
- Do a research on the causes to be able to elaborate the diagram, using methods like check sheet, or any other.
- Construct the diagram by specifying the problem on the right, and choose the categories of causes that will be used, such as measurement, method, people, machines, environment, materials. Or whatever you think is necessary.

Carry out the analysis of the diagram by observing the frequent causes, analyzing those that have a greater influence in the problem's appearance, thus being able to look for a plausible solution.

III. MATERIALS AND METHODS

The study was carried out in an ice cream parlor that serves the public from Monday to Sunday, from 11:00 am to 11:00 pm, with a daily workday of 8 hours per employee, which is between service preparation of the service and delivery of the service together with the payment of the customers. The ice cream shop has 1 queue and 1 service channel.

The methodology applied was as follows, a survey of the arrival and attendance times was performed, and after the queue calculations were performed, the results were used the Ishikawa diagram, whereby the main problems were identified and finally proposed new layout for optimization of the process.

3.1 USED QUEUE MODEL

In order to accurately measure the process times, searching for the solution of the queues required the

collection of the queue arrival data, queue times, and total service time.

Arrival in the queue is the number of customers arriving in a certain time interval, which can generate a probabilistic behavior, which justifies the same arrival of clients at a certain time, for example, the probability of arriving 2 clients every 30 minutes, is visually analyzed in the actual queue, by collecting the time of arrival of the clients and the interval between them, it is possible to calculate probability of arrivals of clients at a given time.

Queuing time is the time that the customer takes when arriving in the queue until being served, which takes time in the process that is very unsatisfactory for the client, and interferes directly in the customer experience, and directly influences the service time. Total time of service is the time of arrival in the queue until the exit of the system, time that appears in the actual experience of the client, sum the previous times with that of the service, and determines the actual time of the service flow, and with it is possible to analyze temporal bottlenecks, and where to improve. In order to better target the collected data and analyzed parameters it is important to map the activity flow, the current layout of the system, being able to propose new layout, and correcting the unnecessary lost times and bottlenecks presented.

The single-queue attendant system used in the system, shown in figure 3, by the design of the current layout, as it is possible to be observed, has an excess of queue causing dissatisfaction in the customers waiting on it.

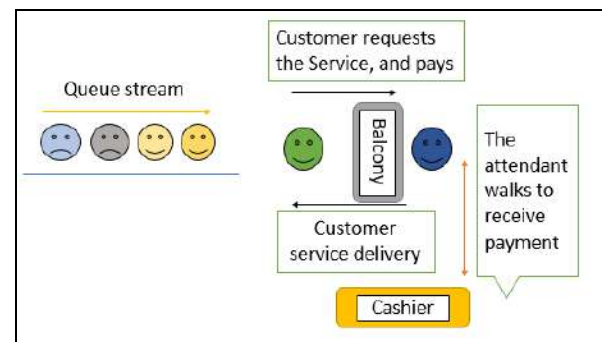


Fig.3: Current Layout

Source: author

3.2 IMPORTANCE OF THE LAYOUT

As the layout becomes old, defects begin to be visible, due to several factors, which can be an increase in productive demand, change in process, among others. These defects create bottlenecks in the layout process, creating unnecessary activities, which cause delays in the process, thus making the layout expensive, because of this it is important to modify the layout so that the current process needs can be met, because the layouts are assembled to meet a specific process, they are subject to

the process, if there is modification in the process should modify the layout, because they are in a connection and depend on each other.

By proposing a new layout in a way that harmoniously assimilates with the variation of the service channels, eliminating unnecessary activities, the system becomes leaner and more practical, being able to complete the service cycle within the necessary walls, improving the customer's final satisfaction.

IV. IMPLEMENTATION

In order to eliminate the system's needs, it was analyzed the important factors for the implementation of the suggested process through the Ishikawa diagram that made visible the main causes that directly influenced the cause of the problem, later the analysis of the current layout where unnecessary activities are observed that influence the growth of the system, generating activities more than necessary, is due to the collection of data at peak service times that demonstrates the reality of the problem, thus proving the need for change, so a new layout, which in sync with the new service process will solve the problems encountered supplying the needs of the demand, made so the practical system is lean towards customer satisfaction at the end of the process.

4.1 LAYOUT ANALYSIS

By analyzing the Ishikawa diagram, we identified the factors that were negatively influencing the queue flow, problems that were in the actual layout that was in the installed system, the factors that were hindering the process flow in the layout, was the position that was the service desk, the cashier that was located a considerable distance from the service desk, since the service and payment was done in the same operation, the employee took considerable time to go to the cashier to make the payment of the customer, unnecessary time that directly affects system time, making prolonged directly affecting the waiting customer, another observation was the lack of visible information about the variety of flavors and containers of different sizes, thus creating an increase in time due to the employee to have a dialogue with the client explaining the formats of services offered and flavors available, an explanation that could be of a visual form and the client would only have some doubt if it were necessary, since the customer would already know the service he wants, thus developing the flow of time.

4.2 IMPLEMENTATION PLANNING

Observing the errors that were explicit in the layout, the need to split the queue demand was analyzed, it was also observed that it was not necessary to create 2 queues because the space was limited and also the demand was

not so great, with the help of the mathematical calculations of operational research it was possible to verify that the minimum number of service channels to supply the demand will be of 2 channels

4.3 LAYOUT IMPLEMENTATION

The crucial part was to propose and deploy the new layout, figure 4: proposed layout, with the necessary corrections for the problems encountered, that goes from the reallocation of the freezers with the nearby box, facilitating the interactivity between the operations, and the informative signs with the flavors and types of service, facilitating the visibility of the customer, who expects to be served the same is already analyzing what will be your request, thus facilitating the time to make the purchase and entertain during waiting in line.

In order to develop the process more efficiently, unnecessary activities were eliminated, with the introduction of the box next to the service desk, with a specific employee to receive and pass the change, thus eliminating an activity that was performed by other employees.

In order to develop the care flow, it was analyzed and found that the use of a single queue with 2 channels of care was feasible to supply the demand, thus making the service quick and practical, since the related activities were lean, eliminating unnecessary ones, and redirecting the important activities in the correct order to be applied.

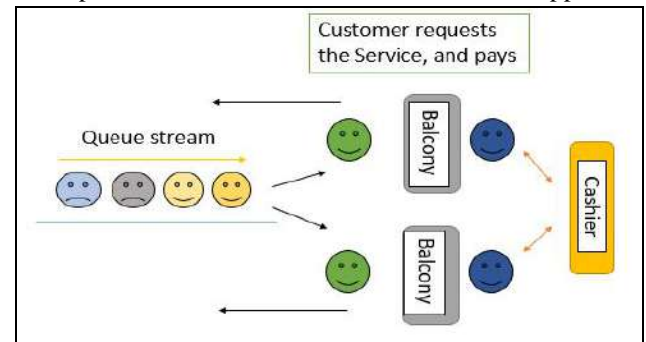


Fig.4: layout proposed

Source: author

The customer upon arrival goes straight to the single queue, while the queue is already analyzing the service you want, and the channels feed and as they are getting free, the time will vary from client to client due to the choice of services that are different and the quantity is also requested, ie a customer choosing a service with greater complexity will take a longer time to be attended, noting that the choice of 1 or more services can occur thus increasing the time in the process, it is worth noting that due to this it is not possible to create a single time parameter for each customer due to these possibility of different quantities and services, the average being used.

V. DATA ANALYSIS

Observing the queue that was formed in the ice cream shop, the data was collected through a digital timer, shown in table 1, the variation of time between arrival, queue and attendance.

Table 1: Data obtained with only 1 channel.

Customers in Queue	Arrival Time (min)	Holding time (min)	Service Time (min)
1	0	3,03	1,93
2	0,38	1,42	0,62
3	0,65	2,35	1,13
4	1,13	4,35	1,91
5	0,53	3,41	2,18
6	1,57	5,25	3,75
7	0,22	2,25	1,37
8	1,28	3,34	2,60
9	1,23	3,67	1,94
10	2,31	2	0,97

With the data collected it is possible to consolidate some information through calculations, using applicable formulas to accurately demonstrate the real situation, thus facilitating the analysis of the facts.

$$P_o = \text{Prob} \left[\begin{matrix} \text{system is} \\ \text{empty (idle)} \end{matrix} \right] = 1 - \frac{\lambda}{\mu}$$

$$L_q = \frac{\text{average number in the queue}}{\text{in the queue}} = \frac{\lambda^2}{\mu(\mu - \lambda)}$$

$$L = \frac{\text{average number in the system}}{\text{in the system}} = \frac{\lambda}{\mu - \lambda}$$

$$W_q = \frac{\text{average time in the queue}}{\text{in the queue}} = \frac{\lambda}{\mu(\mu - \lambda)}$$

$$W = \frac{\text{average time in the system}}{\text{in the system}} = \frac{1}{\mu - \lambda}$$

Note:

λ is the arrival rate.
 μ is the service rate.

Using the data shown in table 1, it was possible to verify the following results:

In the sample of n = 10 clients, it was identified that arrival rate (λ) = 1.07, Service time (TA) = (total service time divided by number of clients) = 1.84 clients / minutes, rate (ρ) = 2.14 clients / minute, average number of clients in the queue (Lf) = 4,03 \cong 4 clients, average number of clients in the system (W) = 3.7 minutes, Average time the customer waits on the system (W) = 5.74 minutes.

Observing the data found in the system with only 1 channel presents an overload due to the arrival rate being higher than the attendance rate with the queue is always

with 4 clients on average, and presents an overload in the client system, thus generating the dissatisfaction of the clients. customers that are waiting in line.

After the new layout was implemented with 2 channels, another data collection was made through digital timer, table 2, following the same parameters of the same data collection, considering the peak time and the same amount of sampling (n) = 10 clients , to be able to compare the two models, the old and the new.

Table 2: Data obtained with 2 channels.

Customers in Queue	Arrival Time (min)	Holding time (min)	Service Time (min)
1	0	0	2,93
2	0	0	0,62
3	1,65	1,2	1,25
4	1,60	2,23	1,41
5	0,50	1,73	1,18
6	1,11	2,65	1,75
7	1,22	1,23	1,85
8	1,08	1,72	1,68
9	0,23	1,85	2,01
10	1,31	1,05	0,79

Using the data shown in Table 2, it was possible to verify the following results:

In the sample of n = 10 clients, it was identified that arrival rate (λ) = 1.15, Service time (TA) = (total service time divided by number of clients) = 1.55 clients / minutes, rate (ρ) = 1.79 clients / minute, average number of customers in the queue (Lf) = 4 clients, average number of clients in the system (L) = 0,64 clients / 5.79 \cong 6 clients, Average time the customer waits in queue (Wf) = 3.5 minutes, Average time the client waits on the system (W) = 5.03 minutes.

It is possible to observe that there was a reduction of the overall time in the system, queuing time was reduced, with the same queue flow and system queues, the queue time was greatly reduced, comparing table 1 with table 2, about 51.28% of the time was reduced by adding a second service channel, leaving the system in equilibrium, the system power is higher and consequently the queue reduces faster, proved by the reduction of 51.28% of the same as previously reported, it is observed that service time was also reduced by around 15.92%, showing that clients are less undecided due to the placement of identification plates, and the service was faster, thus generating a gain end of favorable time, generating a quick and lean flow of time, thus generating customer satisfaction, which is the main goal achieved.

VI CONCLUSION

The application of the queuing theory study in a queue of ice cream shows that the use of Operational Research tools is feasible in small processes and also in simple day to day tasks, demonstrating that it is possible to optimize the performance of real processes, through layout organization.

The system studied had only a single queue to serve a channel, serving 1 client at a time, and it was found that it was overloaded, spent an average of 2.8 minutes in the queue and about 1.8 minutes to be served, showing clearly the delay that the old service system suffered. After applying the new layout that started to be a single queue served by 2 channels, it showed a significant improvement, the average queue time was reduced to 1.3 minutes, and the attendance to 1.5 minutes, the customer service has improved, due to the fact that the service involves several factors, customers take some time to decide the purchase, however it is noticeable that the use of signs and the leaner process influenced the reduction of service time.

Due to the availability of space being reduced, there was an initial difficulty in deciding how to modify the layout, so as not to generate unnecessary costs, because the analyzes are at peak times and at normal times the queue flow is less overloaded.

In order to consolidate the information on customer satisfaction, it is suggested to perform a satisfaction survey to determine if the waiting time is satisfactory, for future studies it is proposed to collect new data at different times and different routine days, such as holidays, weekends, beginning of the month, to see if there is a need to deploy a new service channel in the layout.

REFERENCES

- [1] RINALDI, José Gilberto Spasiani; MORABITO, Reinaldo; TACHIBANA, Vilma Mayumi. A importância da rapidez de atendimento em supermercados: um estudo de caso. *Gestão & Produção*, p. 1-14, 2009.
- [2] MOREIRA, Daniel Augusto. PESQUISA OPERACIONAL-CURSO INTRODUTÓRIO. Cengage Learning Edições Ltda., 2010.
- [3] DE ANDRADE, Eduardo Leopoldino. Introdução à pesquisa operacional: métodos e modelos para a análise de decisão. Livros Técnicos e Científicos, 1998.
- [4] FIGUEIREDO, Danielle Durski; ROCHA, Silvana Heidemann. Aplicação da teoria das filas na otimização do número de caixas: um estudo de caso. *Revista Iniciação Científica*, 2010.
- [5] DE FREITAS FILHO, Paulo José. Introdução à modelagem e simulação de sistemas: com aplicações em Arena. Visual Books, 2001.
- [6] PRADO, Darci Santos do. Teoria das Filas e da Simulação. Belo Horizonte, MG: Editora de Desenvolvimento Gerencial, v. 2, 1999.
- [7] SOUZA, Ana Cláudia et al. Estudo de filas em caixas rápidos de um supermercado utilizando simulação computacional. *Revista Latino-Americana de Inovação e Engenharia de Produção*, v. 3, n. 4, p. 203-222, 2015.
- [8] NEUMANN, Clóvis; SCALICE, Régis Kovacs. Projeto de fábrica e layout. Edição., 2015.
- [9] ROCHA, Henrique Martins. Arranjo físico industrial. 2011.
- [10] SILVA, Alessandro Lucas da. Desenvolvimento de um modelo de análise e projeto de layout industrial, em ambientes de alta variedade de peças, orientado para a produção enxuta. 2009. Tese de Doutorado. Universidade de São Paulo.

The effectiveness and legitimacy of the institute Special Testimony in Brazil and memory

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Abstract— *In this work, we analyze provisions of Law 13,431, from April 4, 2017, which instituted the so-called Special Testimony for the judicial hearing of children and adolescents victims or witnesses of violence, aimed at minimizing the psychological consequences of their participation in the production of oral evidences, as advised by the Federal Council of Psychology, through a technical note, in which it opposes to such procedure, considering that it contributes to the "revictimization" of children who are victims of violence. The main objective was to analyze the effectiveness and legitimacy of the institute, as a guarantor of the rights of these children and adolescents. The approach was interdisciplinary, oriented mainly by theoretical postulates of the fields of memory, psychoanalysis and discourse studies, from which we mobilized some operational concepts*

Keywords— *Criminal Procedure, Memory, Testimony, Violence.*

I. INTRODUCTION

In this work, we discuss the institute of the "special testimony", formerly named "testimony without harm", instituted by Law 13,431 of April 4, 2017, seeking to verify the effectiveness and legitimacy of this procedure as mean of production of legal truth, from the analysis of its compatibility with the principles that guide the practice of psychology as a profession and with the nature of truth objectified by this practice / science and with the nature of the truth proper to the legal field.

The "special testimony" aims to minimize the psychological impacts resulting from the hearing of children and adolescents, victims or witnesses of violence, for purposes of criminal procedural instruction. However, among other allegations, the Federal Council of Psychology (CFP) maintains in the Technical Note 1/2018 / GTEC / CG that the consequences of implementing this procedure would be opposite to those sought by the ordinary legislator, since, instead of guaranteeing protection to the psychological integrity of the minor, it would end up exposing him to a situation of stress and suffering, making him relive the situation of violence suffered or witnessed

We have, therefore, two sciences or practical arts, directly involved in the accomplishment of the special process of hearing of children and adolescents, instituted by Law 13.431 / 2017, psychology and law, which have

different views about the legal discipline conferred to this modality of production of oral evidence, stating formulations on the subject that sometimes contradict each other in relation to the legitimacy of the institute.

II. MATERIAL AND METHODS

The *corpus* of the present analysis is basically composed of two documents: i) the text of the Law 13,431 / 2017, which disciplined the institute of Special Testimony; and ii) The Technical Note n° 1/2018 / GTEC / CG, of the Federal Council of Psychology, which stated a contrary position to the provisions of the above mentioned legal statute, which regulates the Special Testimony.

Because it is a question situated at a point of interaction between the science of Law, more precisely the Criminal Procedural Law, and the Psychology, which despite having points of convergence, present different opinions regarding the hearing of children and adolescents victim or a witness to violence, we opted for an interdisciplinary, as well as a dogmatic and qualitative approach of the *corpus*, from a perspective of analysis of the means of production of truth in the juridical sphere, to which we use, besides works from the field of law, postulates of Foucault ([1974] 2002), and from the prism of memory, when we mobilized the theories of Bergson ([1896] 1999) and Freud ([1896] 1977).

Foucault (1974) states that there are two forms of truth: the "scientific" truth, internal or intrinsic, which is corrected by its own principles of regulation, as in science, and external truth or extrinsic, which is formed in societies in various positions, according to determined "rules of the game", which give birth to certain forms of subjectivity, certain domains of object and types of knowledge.

The legal system of production of truth that prevails today and in which the Brazilian Code of Criminal Procedure is based is derived from what Foucault (1974) calls *examen*, which strongly influenced another system that he identified as "inquiry" and which contrasts with the so-called regime or game of evidence (*épreuve*), in which the criminal procedure was a kind of combat between families, characterized by the absence of a representative of society and the lack of hearing of those who witnessed and / or experienced the events, or by the non-attribution of value of evidence to their testimony

The juridical form of production of the truth that Foucault ([1974] 2002) calls inquiry was based, as well as the examination, by a rational search of the real dynamics of the facts, and was described by the author, from the analysis of the tragedy Oedipus- King, of the Greek playwright Sophocles, as a process of appropriation of the gauging of truth, which was previously on the divine level by the people, through the juxtaposition of scattered fragments, among which the testimony stands out, which assumes, in the tragedy Sophocles, the role of central proof, being that it is through the witness, as was through the testimony that the truth about the life of Oedipus was established.

In the Brazilian criminal procedure system (CPP, art. 155), the evaluation of the evidence is guided by rational persuasion or by the free justified conviction of the judge, a system in which the magistrate has ample freedom in the appreciation of the collection of evidence, being able, in his judgment, to attribute to each evidence produced in the process the value that he deems most appropriate. He must, however, state in the judgment the reasons for his conviction, justifying the burden of proof attributed to each element of conviction relied on in the decision.

The Code of Criminal Procedure in force contemplates several means of collecting of evidences, listed, not exhaustively, in its Title VII, art. 159 to 250. Among those, two are relevant to our work; the testimonial evidence and the offended statements, which may be the object of the so-called Special Testimony. Those means of evidence, in addition to being taken orally, have several common characteristics, more extensively disciplined in the articles that govern the

production of testimonial evidence, among which two are of greater importance for this study: objectivity and retrospectivity.

Objectivity implies the absence of considerations of subjective, evaluative nature on the part of the subject of evidence. This characteristic is expressly disciplined in art. 213, of the Code of Criminal Procedure, *in verbis*: "the judge will not allow the witness to express his personal appreciation, except when inseparable from the narrative of fact."

Retrospectivity, however, implies that the oral evidence will be about facts that are necessarily past; therefore, that can be stored in the memory of the subject of evidence (witness, offended or accused). Addressing the word "memory" as a polysemic term, endowed with different meanings, it is necessary that we discuss some questions related to the mnemonic phenomenon to which the characteristic of retrospectivity of the oral evidence is linked.

The core of Bergson's conception of memory ([1896] 1999) rests on the concept of duration. For this author, it is impossible to conceive time as an orderly succession of facts, with well-defined intervals. In his words: "The division [of temporal flow] is a work of the imagination, which has the function of fixing the moving images of our ordinary experience, like the instantaneous lightning that illuminates during the night a scene of storm" (BERGSON, [1896] 1999, 221).

In his studies, Bergson ([1896] 1999) further differentiates "perception", derived from the senses, from "remembering", anchored in the memory constituted of facts and experiences lived previously. He asserts, however, that such concepts are merely ideal, since the perception, arising from matter (image), is always permeated by memories, in a kind of active present, in which a series of consciences are evoked to help the present moment, whereas, likewise, there is no pure remembrance, since memories are always brought to the surface, bent over a materiality and, therefore, crossed by a perception. Fonseca-Silva (2007) states, referring to Bergson ([1896] 1999), that "the author argues that all perception occurs in a certain duration (name given by the author to time) and implies the intersection with memory, which, linked to a conception of non-spatialized time, accompanies us throughout our lives, maintaining kept in a complete state of virtuality, since it is updated according to present situations and interests (Fonseca-Silva, 2007, p. 15). There is, therefore, in the memory theory developed by Bergson ([1896] 1999), the recognition of the existence of a process of re-signification of the past facts, when evoked in the present, because of the nuances of the

current perception, which is always aided by the by the affectivity and the conjectures of the present events.

Freud ([1896] 1977), in Letter 52, while also addressing the question of memory, states: “our psychic mechanism has been formed by a process of stratification: the material present in the form of traces of memory would being subjected, from time to time, to a rearrangement according to new circumstances - to a retranscription” (Freud [1896] 1977, *apud* Fonseca-Silva (2007, p. 15).

We see, then, that, like Bergson ([1896] 1999), also Freud ([1896] 1977) shares the understanding that there is an actualization, a reframing, a rearrangement of memory in the present moment, so that memory cannot be taken as an indefectible picture of past events. This issue becomes more relevant when such rearrangements of memory occur in relation to legally relevant facts, such as those sought to have access through the collection of statements from witnesses or the offended.

III. RESULTS AND DISCUSSION

The testimonial evidence, as we have seen, assumes decisive role with the emergence of the "inquiry": according to Foucault ([1974] 2002), the Oedipus Tyrannus tragedy marks a transition movement of the verification of the truth that was previously on the divine level, passed to the ruling class and then to the lower classes, thus settling the way in which people obtained the power to judge their own monarchs, through the testimony.

Attributable even to the occupant of the lowest rank in the social hierarchy, the testimony becomes a sound medium for demonstration of truth, in a retrospective condition, turned to the past events, allowing its verification through the intellectual activity, in the sense of linking the statements.

However, the possibility that the testimony contained distortions and / or inaccuracies did not go unnoticed by the Law. In the old Roman provisions on the judicial evidence collection, was established the axiom *testis unus testis nullus*, according to which the evidentiary validity of a single testimony is null and void. This aphorism was not, however, supported by Brazilian law, since, in our system, the validity of the single testimony is admitted.

Malatesta (1996, p. 319), discussing the testimony, states that: “the foundation of the affirmation of the person in general, and of the testimony in particular, is the presumption that men perceive and narrate the truth, a presumption based, in turn, on the general experience of humanity, which shows how in reality and in the greatest number of cases, man is truthful; truthful by the natural

tendency of intelligence, which finds, in fact, more easily than in lies, the satisfaction of a good which is innate.

Still according to the author, this belief in human trustworthiness rules all social relations and without it there would be no possible intellectual progress, since the acquisition of knowledge presupposes faith in the observations and experiences of others. It points, however, to two conditions of credibility, in regard to the person of the witness: first, that he is not mistaken; second, that she does not intent to deceive the judge.

The first of these conditions presupposes the concrete possibility that the witness is mistaken because of distortions in relation to the perception of the witnessed event, as well as because of the (non) preservation of the remembrance.

In regard to this last aspect, according to Giacomolli and Gesu (2008), from an interview granted by Izquierdo, researcher in the area of memory physiology, to the Argentine Journal of Neuroscience (RAN), entitled *The Memory*, which, according to Izquierdo: “in the early hours of its acquisition, declarative memories of long duration are susceptible to interference by numerous factors, from cranial trauma or convulsive electroshocks, to an enormous variety of drugs, and even to the occurrence of other memories. Furthermore, exposure to a new environment within the first hour after acquisition may seriously disrupt or even cancel the definitive formation of a long-lasting memory (Giacomolli and Gesu, 2008, p. 443).

Therefore, even if the witness really believes that he is declaring the truth in his testimony, there is a concrete possibility that the narrated events include divergences from what has actually happened, or even that they do not keep any similarity with the facts occurred, which may result from the phenomenon of perception, which, as we have seen with Bergson ([1896] 1999), is permeated by remembrance.

It is not undisputed, in the jurisprudence of our courts or in the specialized legal literature, that an evidence from an eventual witness or offender shall be attributed the value of an absolute proof, to the detriment of other equally acceptable evidences, taking away from the accused his constitutionally guaranteed presumption of innocence and imposing on him the consequent criminal penalty, notwithstanding jurisprudential precedents that restrain the validity of an evidence to its consistency with other evidentiary elements.

However, there is no denying that such reports are, in many cases, a large part of the body of evidence, with a strong influence on the conviction of the judge, which is why a closer analysis of the so-called Special Testimony

becomes imperative, which is done in the next topic, in which we discuss the legitimacy of this institute as a protective measure of children and adolescent victims of violence.

According to its preamble, the Law No. 13.431 / 2017 "establishes the system of guaranteeing the rights of children and adolescents who are victims or witnesses of violence and amends Law No. 8,069, of July 13, 1990 (Statute for Children and Adolescents)".

With the adoption of this system, a Special Testimony was instituted, which implied altering the procedure for collecting testimony of children and adolescents for purposes of criminal investigation and criminal procedural instruction, seeking to minimize the harmful consequences of their re-exposure to the criminal facts from which they were victims or witnesses. Therefore, the Law 13,431 / 2017 changes the dynamics of the collection of statements, which began to be performed by professionals qualified for this purpose, replacing the usual procedure, which used to be presided over by the magistrate, and necessarily in his presence and the parties acting in the process. The art. 12, caput, of the Law 13,431/2017, establishes that the special testimony will be collected according to the following procedure:

I - Specialized professionals will inform the child or adolescent about the taking of the special testimony, informing them of their rights and the procedures to be adopted and planning their participation, being forbidden to them read the complaint or other procedural documents;

II - The child or adolescent is assured the free narrative about the situation of violence, and the specialized professional can intervene when necessary, using techniques that allow the elucidation of the facts;

III - In the course of the judicial process, the special testimony will be transmitted in real time to the courtroom, preserving secrecy;

IV - upon completion of the procedure provided for in item II of this article, the judge, after consulting the Public Prosecutor's Office, the counselor and the technical assistants, shall evaluate the pertinence of supplementary questions, organized collectively;

V - The professional can adapt the questions to the language of better understanding for the child or adolescent;

VI - The special testimony will be recorded in audio and video.

Although the law does not indicate the technical qualification required by the professional who will conduct the Special Testimony, referring to him just as "specialized professional", it is understood that, given the

nature of the intervention and the legal purpose of protecting the any damage resulting from the conduct of his or her hearing and the remembrance of the criminal acts of which he or she was a victim or witness, such *munus* shall fall on a professional qualified to evaluate the psychic consequences of the collection of the testimony, which requires knowledge and skills pertaining to the area of Psychology.

Notwithstanding that the purpose of the law is to protect the declarant from possible harmful consequences of his / her re-exposure to the criminal acts suffered or witnessed, through the performance of a professional that leads the hearing in the least harmful way possible, the Federal Counsel of Psychology (CFP) has manifested itself, as already seen, contrary to the adoption of the procedure, by means of Technical Note No. 1/2018 / GTEC / CG, expressly recommending that psychologists and psychologists "do not participate in the inquiry of children through special testimony", with the argument that "in the name of protection, the special testimony violates the right of children and adolescents who are the object of preponderant evidence in criminal proceedings, disregarding their peculiar situation as a developing person and their dignity and "that is not the attribution of the psychologist to perform special testimony for it harms confidentiality and professional autonomy."

Discussing on the "testimony without harm", a proposal that served as an inspiration for the current Special Testimony, Conte (2009, p. 74) establishes a series of questions:

When a child is asked to tell about an experience that is of the traumatic order for it, can we use a criterion of truth (objective), leaving aside the enigma of the subjective event that has not yet been dealt with psychically? Is truth a possible category to be thought of, when the event was not translated, repressed, and forgotten? When the event is still an enigma in search of a meaning, doesn't it opens up the possibility of the symbolic?

In the proposal of the testimony without damage two questions are at stake, the search for truth, when the implication of this talk is the arrest of the abuser, usually a relative; the second question is that in view of the non-forgetfulness of the traumatic situation, speaking assumes the dimension of act, putting the event back on the scene.

Thus, the demand for validity in the child's report, when it is exposed to a testimony, evidences a paradox, since it must reveal and hide. Reveal what was asked for the investigation (the objective truth) and hide what happened (the subjective experience of pain, shame and passivity). Speaking appears as a symptom, because it

seeks to reveal the truth (the said) when the psychic (the unsaid) suffering is what overflows. The necessary gap between the spoken and the unspoken can occur in a context of listening to the child, otherwise we can speak of re-victimization.

In other words, what the author argues is that, given the peculiarity of the fact experienced by the child or adolescent, which would still lack processing by its psychic apparatus, enabling repression (confinement of what happened at the level of the unconscious) or elaboration / signification of the event, the submission of the victim to the act of the testimony would imply in a situation of not forgetting the traumatic experience, which, consequently, would lead to a situation of re-victimization of the child or adolescent.

It is also necessary to observe, with Freud (*apud* CONTE, 2009, 73), that "psychic reality is a particular form of existence that must not be confused with material reality", that is, what has been recorded in the psyche of the victim, so as to be capable of remembrance (evocation), does not necessarily keep perfect symmetry with what actually occurred (material reality), thus being the Special Testimony consisting of misleading accounts, not because of the will of the victim to misrepresent the facts, but because of the memory failures to which it is subject and which we discussed above.

Thus, the question of the legitimacy of the institute of Special Testimony finds its focal point in the necessary balance between values equally protected in the Federal Constitution: on the one hand, the dignity of the developing human person (in this case, child or adolescent victim or witness to violence) and, on the other hand, the guarantee of effective criminal protection, which obliges the State to repress the crimes that are subject to its jurisdiction, since it has a monopoly of the power to punish, being disallowed to individuals, except in situations provided by law (legitimate defense, state of necessity, etc) to promote "justice with one's own hands".

IV. CONCLUSION

The views expressed in texts concerning juridical science as well in the texts on psychology show that, although both sciences seek the truth, the material content of the terminology is distinct in each of these areas of knowledge. In the field of law, it is characterized as external truth, linked to the real dynamics of facts that have some relevance to the application of laws, whereas Psychology deals with the "psychic truth", internal to the individual, which does not necessarily manifest strict coincidence with the real dynamics of the facts, being

more related to the perceptions and representations made by the individual concerning the facts he experiences.

The practice of violence against children and adolescents is a real fact that inspires the need for effective action by the State, in guaranteeing the effective protection of these human beings in particular condition of development. However, regarding the subject of the present study, the purpose of protection is found in both poles of the discussion presented above, which is related to the legitimacy of the Special Testimony. The authors of Law 13.431 / 2017 defend that the institute integrates a system that guarantees the rights of the child and adolescent victim or witness of violence, while the Federal Council of Psychology argues that the defense of these rights is given by not adopting the institute, since it violates the special situation of these "people in development."

That being so, and considering that, for the necessary imposition of a criminal sanction on the perpetrators, there is a legal requirement to produce adequate and sufficient evidence to establish the judge's conviction for the culpability of the accused, it is reckless to legality prevent the victims to provide testimony in the judicial context. It is imperative that an attempt is made to harmonize between the defense of the psychic integrity of these subjects and the possibility of producing oral evidence with their participation, so as not to allow its perpetrators go unpunished.

REFERENCES

- [1] Bergson, H. ([1896] 1999). *Matéria e memória: ensaio sobre a relação do corpo com o espírito*. [Matière et mémoire: Essai sur la relation du corps à l'esprit] Trad. Paulo Neves. 2ª ed. São Paulo: Martins Fontes.
- [2] Conte, B. de S. A escuta psicanalítica e o inquirido no depoimento sem dano. In: CONSELHO FEDERAL DE PSICOLOGIA; COMISSÃO NACIONAL DE DIREITOS HUMANOS DO CFP (Org.). *Falando sério sobre a escuta de crianças e adolescentes envolvidos em situação de violência e a rede de proteção: propostas do Conselho Federal de Psicologia*. 1ª ed. Brasília: Conselho Federal de Psicologia, 2009. pp. 71-78. Available: <http://www.crp.org.br/portal/comunicacao/diversos/mini_cd/pdfs/cfp_falando_serio.pdf>. Last accessed on: 05 abr. 2019, at 14h49min.
- [3] Fonseca-Silva, M. da C. (2007). *Mídia e Lugares de memória discursiva*. In: FONSECA-SILVA, M. da C.; POSSENTI, S (Org.). *Mídia e Rede de Memória*. Vitória da Conquista: Edições Uesb. pp. 11-37
- [4] Foucault, M. ([1974] 2002). *A verdade e as formas jurídicas*. Rio de Janeiro: NAU Editora.
- [5] FREUD, S. Carta 52. ([1896] 1977). In: *Edição standard brasileira das obras psicológicas completas de Sigmund*

Freud. v. 01. Trad. Jayme Salomão. Rio de Janeiro: Imago Editora Ltda, 1977.

- [6] Giacomolli, N. J.; Gesu, C. C. di. As falsas memórias na reconstrução dos fatos pelas testemunhas no processo penal. In: Congresso Nacional do CONPEDI, 17., 2008. Brasília, DF. Anais do XVII Congresso Nacional do CONPEDI. Florianópolis: Fundação Boiteux, 2008. p. 4334-4356. Available in: <
[http://s3.amazonaws.com/conpedi2/antiores/XVII+Congresso+Nacional+-+Bras%C3%ADlia+\(20%2C+21+e+22+de+novembro+de+2008\).pdf](http://s3.amazonaws.com/conpedi2/antiores/XVII+Congresso+Nacional+-+Bras%C3%ADlia+(20%2C+21+e+22+de+novembro+de+2008).pdf)>. Last accessed on: 05 abr. 2019, às 11h36min
- [7] Malatesta, N. F. D. A (1996). *Lógica das Provas em Matéria Criminal*. [*La logica delle prove in criminale*] Trad. Paolo Capitanio, Campinas: Bookseller.