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FOREWORD

I am pleased to put into the hands of readers Volume-8; Issue-5: 2021 (May, 2021) 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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Américo Ferreira Neto, Sergio Luiz Pereira, Eduardo Mario Dias, Maria L. R. D. Scoton



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Education for Autonomy at the Child Education Center (CEC) in the city of São Paulo, Brazil

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Keywords— Dialogue, Autonomy,
Teacher training, Sensitive Listening.

Abstract — This article is the result of a post - doctoral research, developed in a Child Education Center (CEC), part of the Unified Educational Center (UEC) Butantã in the city of São Paulo, in a partnership between a national university (Mackenzie, in the city of São Paulo, Brazil) and two international Universities (Siegen University and University of Alanus, both from Germany). The central objective was to show by the direct observation of the researcher during the school routine, how children from 0 to three years and eleven months of age, appropriate the different and multiple architectural spaces of the educational, sports and cultural complex through experiences and the play, where they discover and appropriate the world around them, expanding their creative capacity. The training of teachers in service, the planning of activities by teachers has a dialogical character. Thus, the child is heard in its entirety, and work permeated by Freirian concepts, such as respect, ethics, humility, sensitivity, and utopia. The methodology used encompassed field research, through the observation of children in their daily activities, semi-structured interviews with teachers and management and conversation with the children. (with appropriate terms belonging to the ethics committee - TCLE and TALE). Also, by analyzing documents, such as school projects, Political Pedagogical Projects (PPPs), and a bibliographic survey.

I. INTRODUCTION

The child must be considered as a social actor, as he is a citizen with rights and an emancipated subject in training. Childhood is a social category responsible for the socio-historical construction which constitutes our second semantic field. There is no single or universal childhood. Its meaning can change according to the culture or even the historical moment.

In this context, there is a need to research the complexity and uniqueness of the concepts of child and childhood, as the concepts of child and childhood that we have will structure the entire pedagogical practice.

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childhood, as the concepts of child and childhood that we have will structure the entire pedagogical practice.

Over the centuries, children were seen as unimportant individuals, unable to produce history, without care, a fact that made the infant mortality rate extremely high.

Kramer and Leite [1] approach that the change in the conception of childhood was understood as an echo of the change in the forms of organization of society, of work relationships, of the activities carried out and of the types of insertion that children have in this society.

What we care about is understanding the child from its historical, social, cultural, economic perspective.

Analyzing childhood requires a vision of wholeness, considering the child as a social subject, within a historical perspective, as a subject of rights, a producer of culture.

The child must be observed in his speech, in his behavior, in his productions and in the symbolizations of this subject.

Within this context, as a child producing knowledge, he would need spaces with ample possibilities to develop his skills; enhance learning and enter the culture built over time.

The Unified Educational Center (UEC) Butantã, opened in 2003, was the locus of postdoctoral research. With clear principles of inclusion, respect for children, their culture, it aims to promote access to this equipment for socially marginalized children, investing in popular knowledge “silenced”; within Freire's conception of collective work, the ability to listen to the other.

We understand that children are competent social actors in the construction of their social life and the lives of those around them and who act in a proper and intentional way in the times and spaces in which they find themselves, through the interactions they establish with their peers, with adults and with the society in which they are inserted.

The object of research was to analyze how the appropriation of children occurs in educational, cultural, sports, artistic and architectural spaces and the UEC space was the “stage”, where we could make our observations. Promote access to this equipment for socially marginalized children, invest in this popular “silenced” knowledge; within Freire's conception of collective work, the ability to listen to the other and participatory management, it brings UEC residents together and among themselves. We understand that children are and should be studied as competent social actors in the construction of their social life and the lives of those around them and who act in their own and intentional way in the times and spaces in which they find themselves, through the interactions they establish with their children. peers, with adults and with the society in which they are inserted.

The research was based on authors such as Paulo Freire, Walter Benjamin, William A. Corsaro, Milton Santos, Lev Vygotsky and others who enhance the importance of relationships, the practice of freedom, autonomy, care to give voice and time to children, making them protagonists of their apprenticeship.

The initial hypothesis that the child appropriates the educational and social spaces and transforms it; at the same time that it is transformed by him, through games, games and that this interaction with different spaces

enhances learning, the exchange of knowledge and experiences was in fact proven by some aspects: joy and pleasure of children in being in that space, sharing discoveries, yearnings, fears with the class group; respect, time and voice that teachers give children; the concern of teacher training for quality education and with fair precepts.

The relevance of the research was based on the choice of UEC, precisely because it is a differentiated Educational Complex, providing more possibilities for our investigation on the appropriation of different spaces by children from CEC.

The educational principle that guides the UEC Butantã project is to provide a type of education that enables integral development for children, adolescents, youth and adults, including formal, non-formal education and socio-cultural, sports and recreational activities as forms of learning.

II. METHODOLOGY

From the collected data, we raised some categories for content analysis, as proposed by Laurence Bardin [2], by the categorical thematic analysis, where the frequency of certain themes is evoked and grouped into significant categories and formal analysis of the utterance, which marks a revealing discourse, requiring repetition, order of discourse from the researcher; gaps; of the unspoken.

We also used an instrument called *narrative map* or *cartography*, in which grouping words that were part of the observation process during the research of the group of teachers and managers, pointing out speeches, memories, affections of and among children.

Throughout the analysis of the data collected during this research, some categories were established, which will be analyzed in the next section, which bring the interviews with semi-open questions with teachers, managers, and children. By the feedback in the interview and by our observations, we understand that the space educates.

The categories raised by the researchers were: conception of the concept of child; curriculum; appropriation of space; Political Pedagogical Project (and other institutional documents); and playing.

It is worth mentioning that the professional career established by one of the researchers of this paper as a teacher in public schools at Municipality of São Paulo (PMSP, acronym in Portuguese) has provided us with challenges, searches, achievements, reflections, exchanges of experiences always and many concerns.

Thus, this research did not arise by chance; on the contrary, to understand the way in which spaces are appropriated and the relationships with the knowledge and practices established between the environment in which the five-year-old children live and how these relationships are expressed at school.

During the research, several discoveries emerged that reiterate the conception of children as a producer of knowledge. Some of these discoveries point to the child as a natural researcher, precisely because of his anxiety.

Based on conversations with teachers and managers, reading documents, projects we opted for content analysis using Bardin's approach.

III. RESULTS AND DISCUSSIONS

In this journey, it was noticed that there were born researching professors, who did not understand themselves as such. In teacher training, we even talked about being an educator, teacher, researcher. These trainings take place in the collective hours of study of teachers and there are moments of monitoring with managers and teachers to support the development of inclusive pedagogical practices based on the theoretical aspects discussed in training.

In addition, throughout the year, workshops are organized that are open to the participation of children, family members, guardians, residents of the surroundings, as well as professionals from the units' support staff.

These workshops seek to foster the strengthening of the bonds of the school community and the understanding of the importance of play for the development of all children.

I was able to observe, in the routine, interactions with respectful children on the part of the entire CEI group and incredibly positive ones that transformed the interests of these children into projects with the involvement of families and the community.

Knowing how to listen to a child goes far beyond listening to them and answering something. It is to include it, to respect it, to give a turn, the voice, to become an instrument so that it can make its dream possible. It requires a lot of patience, love and dialogue. As Freire [3] would say, fundamental knowledge is needed to program any political-pedagogical action: "change is difficult, but it is possible", assuming the ontological vocation of "being more".

Paulo Freire [4] understood and described the continuous process of humanization, initially raising the issue of human beings' ontological vocation: being more. To this vocation, Freire identified it as the humanization process of human beings. But, beside it, he presented the

distortion of that vocation, that is, the dehumanization present in the history of human beings. To overcome the dehumanization of human beings, it is necessary to educate them so that they can become aware of their condition as dehumanized beings and set out in search of their humanization.

Freire [5] states that unlike animals that are "beings in themselves", human beings are "beings for themselves". And that they are dehumanized when subjected to processes that make them "beings for the other". Freire [6] points out that human beings are not beings that only exist in the world, but are in full relationship with this world, and in this way, they are able to become aware of themselves and the world.

The conception of a child that they believe according to semi-open interviews with educators is that the child is a producer of cultures, which are created from the reality that he lives, what he feels, what he thinks and does, and I highlight: "Knowledge of a child is constituted in the interactions, therefore it is fundamental to assume our task of mediators in the educational action". (Teacher speaks).

Still in the semi - open interviews, most of the research participants point to CEU as an element that enhances experiences, exchanges of cultures, knowledge, and actions with the community. They value the coexistence that the CEU architecture itself provides, because in this way, the community respects the space that belongs to it, reducing the violence rate in the community. They reiterate that they offer social quality education to the surrounding community.

One aspect to be pointed out in these statements is the understanding that the collective space with adults and children as an educational environment aims to guarantee the right to childhood, the right to play, to express themselves in the most varied forms, allowing for a cultural exchange.

When asked about playing and the relationship with learning, they were unanimous in answering that it is playing that the child learns; interacts; exchange experiences and share with your family members, who give new views on a particular game as a feedback, putting a little bit of yourself, in what was the other's and now, it becomes everyone's.

The starting point is always what the little ones bring and what they produce among themselves by interacting with the world and thus, they carry out processes of signification. In this sense, it starts from a conception of education that sees reality as a historical, cultural, social, and plural construction, therefore dynamic, contradictory, and subject to change.

It also presupposes a theory of knowledge that has the social function of human emancipation, within a Freirian conception.

According to Freire [7] “[...] propaganda, leadership, manipulation, as weapons of domination, cannot be instruments for the reconstruction of oppressed men ... There is no other way but the practice of a humanizing pedagogy, in which the revolutionary leadership, instead of overcoming the oppressed and continuing to maintain them as almost things, he establishes a permanent dialogical relationship with them”.

The CEC/UEC space allows exchanges, dialogue, discoveries. In this sense, the choice of the locus of research was especially important to prove our initial hypotheses and validate, at the same time, a quality education.

Corroborate with Horn [8] when “[...] It is in the physical space that the child can establish relationships between the world and people, transforming it into a backdrop in which emotions are inserted [...] in this dimension, space is understood as something conjugated to the environment and vice versa. However, it is important to clarify that this relationship is not linear. Therefore, in the same space we can have different environments because the similarity between them does not mean that they are the same. They define themselves with the relationship that people build between themselves and the organized space”.

The need and importance of the interactions that occur within the spaces were evidenced, which are of great influence in the child's development and learning.

According to Vygotsky [9] "human beings grow up in a social environment and interaction with other people is essential to their development".

Thus, a stimulating environment for the child is one in which he feels safe and at the same time challenged, where he feels the pleasure of belonging to that environment and identifies with the same and especially an environment in which he can establish relationships between the pairs. Thus, it is not enough for the child to be in an organized space, but it is necessary for him to interact with this space to live it intentionally.

For Vygotsky [10] the social environment is a major factor in the construction and development of individuals.

According to Horn [11] “[...] toys have always been part of children's lives, regardless of social or cultural class in which they are inserted”.

The habit of playing is intrinsic to the child. The fact that CEU Butantã provides several spaces for the child to play and act within them, proposes new challenges that

will make the child an agent of his own learning in a more playful way.

After field observation, we can say with regard to the children of the CEC, that article 7, specifically items I, II, III, V of the Political Pedagogical Project had its objectives fulfilled: the promotion of the integral development of children.

UEC is a development hub for the territory; it is a pole of democratic, emancipatory and innovative educational experiences; and a reference center for promoting social equity in the territory.

We corroborate with Moura [12], who, when addressing the children's school space, highlights how fundamental the search for quality early childhood education is. The author adds that her planning is never neutral.

Kowaltowski [13] states that there is an influence of the architecture of the school space on learning, suggesting that the architectural and pedagogical projects should be in line with each other.

The child identifies himself with the space by elements of his culture, by gratifying experiences that happened there and by the exchange with other subjects who share the space. Then there is the appropriation of space.

The psychological effects of the appropriation of the school space reinforce the child's self-image in front of him and in front of other colleagues, developing a social sense of community. The pedagogical effects of the appropriation of the school space develop the sense of creation, expose their skills, the sense of order and the inserted aesthetic values that are nothing other than social values.

The physical context is constituted in spatialities where interactions and social relations take place. In this perspective, the construction of social identity is based on the place and environments that provide positive relationships and interactions for people.

We understand that the appropriation of these educational spaces meets the requirements of art. 3rd, where CEUs are educational spaces that consolidate the integration between education and life, ensuring the right of access to knowledge, culture, art, sports and leisure, recreation and technologies, linked to local knowledge and potential around a meaningful and socially relevant educational project for all generations, also constituting a space for organizing the popular strata through the valorization and expansion of their knowledge.

Finally, we see how children discover, make contact, experience and play in the physical space: sand, toys and the symbolic aspect; their freedom of expression, of action.

The child appropriates objects and phenomena from external reality and internalizes them through play, being able to use it in favor of his fantasies.

Currently, there is a need and relevance for children's active participation, both in research and in other social practices that are part of it. As the school is conceived as an important cultural locus in the children's lives, there is nothing more evident than the need to create pedagogical interventions that respect the children's participation rights in the entire educational process, aiming primarily at their autonomy, independence, and preparation for solving problems and conflicts in school and family life.

Investigations on childhood, education of children and their relationships, such as those of Barbosa and Horn [14], Edwards & Forman [15], Campaner et. al.[16], have emphasized the needs and potential of young children in early childhood environments, defending the right to be heard: "sensitive listening" and to participate in the educational processes that are part of it.

It is important to develop the pedagogy of listening, aimed at early childhood, in which the child is the center of pedagogical practice.

The interaction with the various UEC spaces, mediated by the teacher, establishes confidence in the appropriation of the new spaces and in the interrelationships, making the children protagonists of their development and learning process.

Playing is extremely important for the child. Enabling this space of pleasure, playfulness, expression, provoking children's actions, or reactions is a way to unveil the world and often the knots.

Benjamin [17], made some important reflections on the playfulness, considering its cultural aspect. Toy and play are associated, and document how the adult puts himself in relation to the child's world.

Benjamin's studies showed how the toy has always been an object created by the adult for the child. According to Benjamin [18], it was mistakenly believed that the imaginary content of the toy determined children's play, when in fact it is the other way around: the child does this. For this reason, the more attractive toys are, the more distant they will be from their value as instruments of play.

Through playing that the child meets the world of body and soul. He realizes how he is and receives important elements for his life, from the most insignificant habits, to determining factors of the culture of his time.

Playing, the child sees and builds the world, expresses what he finds difficult to put into words. It is by playing that the child learns that when the game is lost, the world does not end. "[...]the real, the imaginary and the

symbolic are firmly articulated in childhood and, for that, the child will have to learn something " [19]. Thus, we cannot think of childhood without playfulness, because it is through it that the connection between learning and development takes place, which is why it is impossible to deny its importance.

It is in the world of make-believe that children put the way in which they find themselves today in front of their parents, their peers, sexuality, school, objects, ideals, the symbolic. In this way they have fun (change the end), with their pain and beauty making use of fantasy to elaborate reality and find forms of subjectification in this process.

Thus, the play category is mainly a social and cultural activity and is widely used in the educational spaces of CEC.

Walking with teachers and children, we understand that the CEI has a democratic-participatory model in decision-making that occurs collectively through the search for common goals assumed by all.

Children develop their activities freely; talk to each other a lot; share knowledge; reinvent proposals pointed out by teachers.

The teachers, in turn, listen to the children, giving them time and a voice. The notion of belonging to a group is incredibly significant in social, ethical, affective, aesthetic and psychological aspects.

Children's participation and involvement in the proposed activities give the child autonomy and decision-making.

Democratic management goes beyond the decision-making process, it identifies problems, monitors and controls actions in the inspection and evaluation of results. Thus, with the democratization of management, the participation of people is increased.

According to Libâneo [20] "[...]Thus, schools can chart their own path involving teachers, students, staff, parents and the surrounding community, who become co-responsible for the institution's success. This is how the school organization becomes an educational space for collective work and learning".

As for the questions related to playing answered by the children, we understand that the experience of playing crosses different times and places: past, present and future; always marked by change and continuity.

The child, being situated in a historical and social context, incorporates the social and cultural experience of playing through the relationships he establishes with others - adults and children, through the reframing that the child brings again, with his power to imagine, create, reinvent,

and produce culture. Playing therefore involves complex processes of articulation between what is already given and what is new, between experience, memory, and imagination, between reality and fantasy.

Our observations lead us to realize that play requires learning a specific form of communication that establishes and controls a symbolic universe and the interactive space in which new meanings are being shared.

We believe that it is the informal game plan that makes it possible the construction and expansion of skills and knowledge in terms of cognition and social interactions.

The analysis of the narrative map's points to the appropriation of the CEC / UEC spaces in a pleasant way by the children. It reiterates the value of experience, the exchange between children, meetings, searches, conflict resolution. They tell a little about the observed group, their experiences, preferences and, in a way, also their dislikes. The cartographic strategy allows to escape the reproduction and repetition of oneself, making possible the singularization, the production of oneself based on new aesthetics of existence, subjectivity.

Remembering Deleuze and Guatarri [21] "[...] the map is open, can be connected in all its dimensions, dismountable, reversible, susceptible to constant changes. It can be torn, reversed, adapt to assemblies of any nature, be prepared by an individual, a group, a social formation. You can draw it on a wall, conceive it as a work of art, build it as a political action or as a meditation. One of the most important features of the rhizome is perhaps that it always has multiple entries; (...) A map has multiple entries contrary to the decal that always returns to the 'same'".

Children really take ownership of educational spaces through play and games; through the exchange of experience with its peers and mainly because it is a pole of human and social development of the community in which it is inserted, it makes them possible and as provided for in the regulations, it promotes the integration of spaces and equipment among themselves and with the general public (community and other users).

In addition, the act of playing is exposed to the social and cultural influences of the environment. The child, under this influence, assumes several roles and ends up being considered as a producer of culture.

IV. CONCLUSIONS

The accomplishment of some daily tasks intentionally structured, by the teacher ensure that the routine makes the children encounter the succession of moments and what they can do in each one of them. Security and trust are the

result of routine. From the room to the other CEU spaces; the group outing, the space exploration of other environments such as theater, park, swimming pool, court.

From what I could observe in the documents and in practice with the children and teachers, we can infer that our hypothesis is correct: the different educational spaces provide meetings, exchange of experiences, develop cooperation, enable inclusion and a more pleasant, playful and healthy learning, as UEC principles, which advocate the organization of a quality public educational system; teacher training; respect for the historical inequalities in educational opportunities and human life of the population the Program serves.

The experiences in the UEC's dialogue with each other, overcoming the existing inequality through the organization of school time, the curriculum, and the occupation of the school unit by the community.

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The main research has given visibility to the concept of territory and Unified Educational Center (UEC) Butantã due to the benefits provided by the educational and social complex to students, their families, and the surrounding community.

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Efficiency Location of Single Wall Outrigger and Wall Belt Supported System in Transverse Direction: A Review

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Keywords— *Lateral loads, Multistoried building, Outrigger system, Plinth Level.*

Abstract— *Each building requires a system to survive a system of resisting major forces caused by wind speed or heavy earthquakes. One of the finest arrangement is outrigger. Outriggers of structural elements hold the arrangement of earthquake loads together. When the difficulty of the tallness of the structure is greater than before they turn out to be larger as well as the addition of tempting additions to oppose systems such as truss consists of belt and outriggers is essential. consumption of structural regulation adds structural power by connecting the main building with the remote colony and making the whole body function as a single unit in opposition to the trouble.*

The present review articles deals with the research based on the Outrigger Wall and Wall Belt Supported System by different researchers. The observation includes based on the reviews in that inputs of Outrigger Wall and Wall Belt increase the performance of building in terms of stability, stiffness, strength & cost.

I. INTRODUCTION

The examination of the seismic activities of the earth artificially via structural software reveals that whenever the R.C.C. multistory structure has located around the area of epicenter of any earthquake, the waves create a harmful effect on it. So, to counteract the lateral forces in the design of tall structures, the parameters to be maintained are strength, resistance against lateral deflection, stability to avoid structural and non-structural destruction. For the design requirements, structural examiners have offered new systems to maintain the above parameters are to use shear wall, truss systems, moment resisting frames, base isolation systems and one of them is outrigger and belt supported systems. In this system, when the structure rotates against lateral effects undergoes deflection and rotation.

To counteract this, stiff core is provided in the middle of structure connected by stiff arms that resists the whole structure and transfer all the lateral loads around the beam-

column connections. Hence the performance of the multistory building depends upon the stiffness generated system.

The stability of tall structures requires some modifications into it since the scarcity of land generate need of the tall structures such as multistory building and skyscrapers. Since it has been observed that the competition is going on among the countries. Since the loads on the structure such as vertical and horizontal loads itself generate a huge combined load that has somehow generated by structure and that load has to be bear by structure itself. Since the earthquake generates oscillations from the ground which is connected to the structure and the most effective technique used to resist the structure by these combinations is the use of outriggers, belt supported system and outrigger and belt supported system.

Outriggers:

Outriggers are defined as the members who consist of the beams or contact plates from the centre to the outside

of the posts on both sides that block the structure and operation of the connecting links. The core was provided as a detachable bar holding the entire structure firmly to accommodate loads and moving equal loads out of poles.

Outriggers are the members of beams or plates connected from the core to exterior columns in both the directions that hold the structure and act as frame connections. The core provided such as shear wall core holds the entire structure firmly that accepts the loads and transfer the loads equally to the exterior columns. This system provides more stiffness to the structure than conventional frame systems. Greater stiffness is accomplished in this type of structure than conventional frame. An outrigger combines the two elements adding a strong solid that interferes with emergency power. If an outrigger-reinforced building under wind or seismic loads deflection, the outrigger connects the main wall to and away from the posts, a unit to resist lateral loads is act on replaced the full structural system.

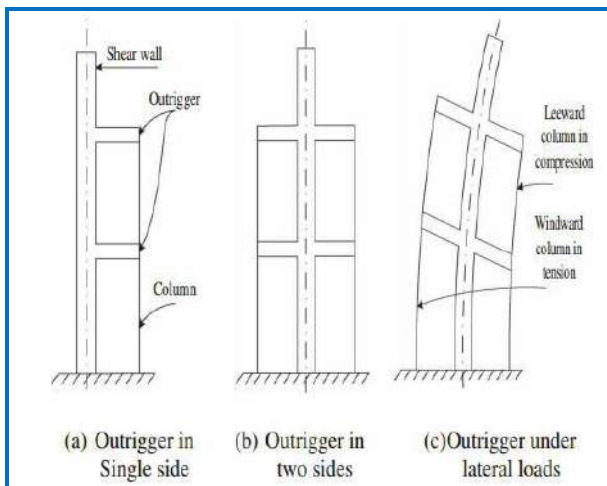


Fig.1: Concept of Outrigger (a, b) & its effect in Lateral Loads (c)

Belt supported system:

The best technique used in huge-story houses is to maintain the body whether it is a bar belt or a truss belt system. It representatives to the structural nodal points & communicate through it. The most efficient system used in multistory building is the bracing system either it is wall belt or truss belt system. This system is the connection of the members to the nodes of the structure. It is called as belt supported system because the belt generally made up of trusses or shear wall, connects the periphery columns of the structure. The load moves from each member distributed to the connected structures evenly. They are termed as belt support systems the reason is the belt is usually made of trusses or bolts, connecting the structure line. The load departs from each member being distributed

equally housing. In order to adapt to the force of the wave and to maintain the stability of the structure, the outer straps and straps are used.

The Policy is that the outer poles are fitted with the centre of the bar with the braces and straps in one or more positions. The truss straps are attached to the outside pillar of the house while the outside holds them to the main or central vertical wall. The reason behind is this approach due to reduction value is occurs in interference structure with respect to the conventional method.

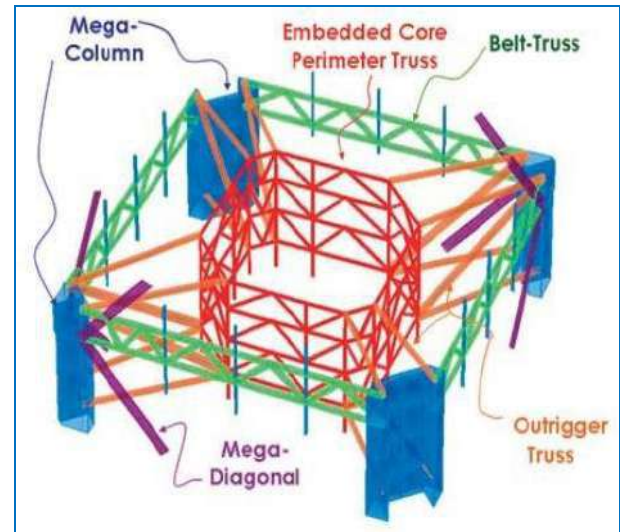


Fig.2: Typical Concept of Belt Supported System

II. LITERATURE REVIEW SUMMARY

A review paper is an article to obtain the present situation of a subject and to recognize the present situation demand. A review article observes and short way to stand for past published work based on learning, rather than reporting new facts or analyzes. It is termed as investigation articles or, in news release, outline of articles. For the present project the review of article is based on the Outrigger Wall, Wall Belt and Outrigger structure Subject area so that it is easy grapes the subject knowledge and implementation and future orientated work is carried out with the help of the reviews.

1) Nadh V.S., Sumanth B.H. (Feb.-2020)

The articles are based on the study of the design of beam and beam systems for tall buildings. The primary focus is provided on optimal topology and outrigger system size design. The guide will provide an explanation and description of the theories, assumptions, concepts, and methods used in the reviewed articles for optimal topology and size design. The review obtained is useful to understand how different parameters influence the optimal topology and size design of a tall building with truss and truss system. The system meets the initial and final design

stages. The codal approach is also adopted by composing a standard or special code for designing tall buildings.

2) Patel N. & Jamle S.(Aug.-2019)

The researcher's patel & jamle worked on outrigger system is made for details because of the fact that the best system is available for high-rise buildings and on the skies. In this system, the outer lines are connected to the main inward or outward path by strong loads on different floors against the shock and moderate action of the main parent should be seismic and windy. In this paper various papers presenting this subject are reviewed to perform a great deal of work done in this first field. On reviewed the research, it comes about the proven result that drives the development of our research. It also faces the multi-story building to do details for the 13 floors. A total of 13 cases are shown in twin towers with different floor sizes and the best conditions are notoriously resistant to movement. The tower is being considered for zone 4 against dirt roads. Studies have been completed against different segments of seismic, there is an increase in the pit & it is on the roof. Preliminary results of more than one case and the various cases are recommended with the help of statistical data and analysis Staad-pro. The main component of the welding plate is a flexible part of the welding wall, its width and thickness.

3) Dangi A. & Jamle S. (Sept.-2018)

Researchers are testing the Ground with ten Storey, 3-dimensional modeled under the influence of earthquakes. Site outrigger based on Taranath method. Response methods have been used for monitoring the performance of seven-stage configurations including conventional, core welds, outrigger and wall belts and outrigger and truss belt support systems. The Base velocity, axial column strengths and members of the axial velocity were studied. Very good chapters for all the topics discussed in this article as well. The results of the Base Shear show that the response is more important than the general structure which seems to be very useful under the normal wave of the normal structure and the main separation. Shear Core outrigger and wall support systems show significant correlation between all time-resistant cases. Underneath the powerhouse shows a great deal when only Shear Core applications will be used. both concepts are useful in separating forces for both Y and Z sides in agents. The regulation of the agents saw good and good sanctity for the construction in the lower partition and the fence. Summary parameter management issues in both Shear Core outrigger and bar support systems. The latter as a Wall strap Wall is more useful than system truss straps.

4) Soni P., Tamrakar P.L. & et. al.(Feb.-2016)

A list of articles being made for the study of the improvement of spinal cord and their behaviour towards emergency loads. While vertical walls resist large areas of lateral load on the basement of the building and lateral load supported framed on the building consist upper part which is suitable for weak high-rise buildings, buildings are similar in nature built in India, as per India habituation concept floors are utilized as a parking and garages or offices and the upper floors places. This result of the G + 10 structural velocity project reduces the importance of von-misses reinforcement and structural changes in site 1 compared to site 2. Similarly the result is in G + 20 wall-to-wall structures have less significant fracture sites in site 2 compared to site 1. The end of the G + 26 floor structure was concluded to reduce the importance of von-misses sites and less inconvenience to the structure in place 1 compared to place 2.

5) Fawzia S., Nasir A. & et. al. (2011)

This work is based on the effects of hurricanes and the evacuations of people outside of the 28, G+42and G+57 are being studied. There are some decisions have been made that will prohibit the opportunity to worked on upcoming area for the researchers. The civil engineer. The results of the demonstrations have significant implications for the higher structures. The increase is high but the same strategy is in place to reduce the complexity. To meet the maximum tensile need bracings are added and also the addition of additional resistance resistors for example truss straps & outriggers is required.

6) Herath N., Haritos N. & et. al. (2009)

This study is needed to identify the best location outside of high-rise influence of seismic conditions.. The storey consist 50 floors buildings surveyed and the levels having a highest peak in 3 levels of ground acceleration on the velocity of the points in each segment of the earthquake data were combined to provide a similar level of roadmap. The analysis of the response and behaviour of the building was considered with regard to the legalization of responses such as relocation and safety on the premises. This study showed that the standard deviation of the setting when the external level is 22-24 is higher. Thus it can be concluded that the optimal location are obtained in the range of 0.44-0.48 times its maximum location.

7) Das U., Pal A., Vishwakarma A. & et.al.(Oct.-2020)

Every Structure needs a table to withstand a system of resisting other forces caused by wind or strong earthquakes. One of the best programs is outrigger. Outriggers of structural elements support the formation of

lateral loads together. When the complexity of the height of the buildings is increased they become larger as well as the addition of tempting additions to resist systems such as truss consists of belt and outriggers are needed. Utilization of structural regulation adds structural strength by connecting the main building with the remote colony and making the whole body function as a single unit in resistance to the burden. The current review articles deals with the research based on the Outrigger Wall and Wall Belt Supported System by different researchers. The observation includes based on the reviews in that inputs of Outrigger Wall and Wall Belt increase the performance of building in terms of stability, stiffness, strength & cost. It also concluded that this performance are vary with variation is occurs in the location and dimensions parameters such height, depth and plan areas. The research also impact on the system is used as per the guidelines provided.

8) Das U., Pal A., Vishwakarma A. & et.al.(Oct.-2020)

The demands of multi-story building with architectural impact are increases day by say in all over the world. The multistory building improvement has spread rapidly around the world because now, people try to live in multi-storey structures. A Structure is said to acceptable if it satisfy the design criteria in it to resist the lateral forces. Loads mainly from severe earthquakes. The shear wall was implemented to resist lateral loads. To fulfill these aspects the Outrigger & wall belt system should be used in the structure. In this project a G+20 Storey structure is analyzed using six different cases named as HP1 (Horizontal plan1) to HP6 (horizontal plan 6). 1 to 6 indicates ground level to 20 storeys. In this study a multi storey building consist of structure made up of G+ 20 storey's building in Zone III. The plinth area is taken as 900 m². The 5 bay & 6 bay with grid spacing is taken 5 m. & 6 m in x and y direction respectively. For determination of Performance of structure under efficient location of single outrigger wall connection and wall belt supported system over horizontal plane in CSI-ETABS different levels of building is major objective of project. The project concluded that Optimum height for placing shear wall belt to increase lateral load handling capacity from above objective parameters will be at 11.50 m i.e. structure with shear strip at 3rd floor. Two more location also predominate in it ie 3rd & 6th floor. Analytically If N no. of storey is taken than optimum location lies under $((N/2)-1)$ to $((N/2)+1)$, most preferably at $(N/2)$ Storey.

9) Abrar Ahamad, Ankit Pal & et. al. (2020)

In the current era or scenario, the G + 12 structure located in zone III is considered for analysis. The analysis is

carried out for seismic zone III. The structural model is analyzed and compared with different porch locations for seismic zone III according to IS 1893-2016 for analyzing the response spectrum. Results are assessed for offset, line offset, baseline offset, etc. Results are obtained and presented as plots and tables for the seismic zone. A building with a porch exposed to seismic effects with seven different locations, based on the analysis results, was obtained for seven locations of a multi-storey building. The results show several results: maximum displacement at location 7, maximum basic shear at location 1, maximum axial force at location 6, maximum column shear force at location 1, maximum location 1 of the column bending moment, beam shear force

10) Abrar Ahamad, Ankit Pal & et. al. (2020)

This article provides a short description of determining the best porch location with the help of Staad-pro. The analytic approach is used under it. The article aim is seismic wave's effect; Staad-pro approach is used under it. This article concludes that it is really important to use analytical methods before building multi-story buildings in seismic and non-seismic areas. After studying all the documents, we can easily understand the importance of analytical methods. We can easily calculate the effect of seismic loading using programs such as Staad pro and Etabs before the construction of multi-storey buildings. Calculation and modeling is the main purpose of the conclusion.

11) Mahendra Kumawat, Ankit Pal & et. al. (2020)

In this era of multi-story building design and architectural vision, a new idea is required. The diverse competitors surrounded by them made the construction with their own choice, as well as market demand and a multi-story structure, perform extremely important work in innovative and new fields. This should explain the complexity of the production of the region, along with the architectural and structural point of view. Composite and varied floor arrangements on similar substrates require reliability with a constructive approach. These types of structures are the Twin Tower structure used in this modern globe. In this study, outcome evaluation parameters such as floor displacement and drift are derived from the props of the multi-story structure of the twin tower located in Zone III earthquakes, earthquakes impact the structure under 5 different shapes, and studied with Staad pro assistant software design

12) Aasif Khan, Ankit Pal(2020)

The structure is now ready with a lot of modern traditions such as tall construction, etc., and there the need is met with fresh modernization and latest thoughts. Many associated innovators have used them to build a structure

with their own alternative as well as market demand. The parameter estimates for consequences such as floor displacement and drift are derived from the foundations of any multi-story structure located in an earthquake. Zone III, earthquake effects affect the building under 7 different best sized columns to reduce baseline displacement. For base shear reduction, use the best column size of columns with the same concrete class in a multistory building under seismic loading to study base shear reduction and verify with the E-Tabs design software alliance.

III. CONCLUSION

Based on the diverse researchers learning on Outrigger Wall and Wall Belt Supported System the subsequent conclusions are to be prepared. The points out conclusions are as follows:

- The systems minimize hindered space compared to the traditional method. The floor space does not contain any columns and remains among the core and the external columns; as a consequence, increment in the functional efficiency of the building occurs.
- The belt truss & outrigger system most accepted method for withstanding under lateral loads.
- The structural form used by the Outrigger System for High-Rise, Composite Structure, Multi-Outriggers System, Unsymmetrical Tall Buildings, Steel Structure & braced frame system by different analysis. The bracing & Outriggers System is more priority in it and reduces the effect of laterals loads.
- Under the behaviour of the soil–structure interaction, the systems consist fixed base, location consist of the belt truss at the higher stories imparts the lesser amounts displacement.
- The main aim of the researchers is to increases the Stability of the building used, hence increment is observed by different researchers.
- The maximum research is based on the optimum height, shear wall location and height, variations in outrigger depth etc.
- The checks made by different researches are Seismic performance, Impact in the Cyclonic Region, Guideline adopted under for Optimum Topology concept and Design consideration under sizes.
- Difficult connection due to the core is removed & with outrigger system, the structural materials can be applied effectively by utilizing the axial strength and stiffness of exterior columns.

IV. FUTURE SCOPE

The following future worked as carried out to get the knowledge of truss belt and wall in the structure and to find deeper concept and new considerable idea through it. There are as follows:-

- Outputs based on the efficiency of outrigger.
- Use of different types of structural form such steel, bundled tube, bracing etc and comparisons between them.
- Dimensional analysis: variations in the depth, size of the belt truss and wall.
- Locations based assessment of the structure to get optimises location for earthquake resisting building.
- Dynamic wind analysis such as CFD analysis or wind tunnel.
- Earthquake approach comparison such as RSA & THA.
- Use of different type's base isolation in the truss belt and outriggers system.

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Video Analytics on Social Distancing and Detecting Mask - A detailed Analysis

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Keywords— Deep learning, Social
distancing, Covid19, video analytics
technology.

Abstract— During this pandemic circumstance of Covid-19, social removing has become a standard general wellbeing mediation around the globe. Through social separating, wearing the face mask and try not to be in the group can slow the spread of Covid-19 illness. This survey is focused to inspect whether the people in a public maintains social distancing. It also checks whether every individual is wearing face mask. If both are not done, an alert is given to the public for maintain the social distance and it detect whether the individual is wearing mask or not. Applying deep learning algorithm to maintain social distancing in public place through video analytics technology.

I. INTRODUCTION

Under the flow COVID-19 foundation, it is fundamentally imperative to control the spread of the infection. have shown that veil wearing can essentially diminish the danger of COVID-19 transmission. Notwithstanding, it is absurd to expect that everybody is capable and able to wear a cover.

Video analytics

It is an innovation that measures an advanced video signal utilizing an uncommon calculation to play out a security related capacity. for example, fixed calculation investigation that is intended to play out a particular assignment and search for a particular conduct. Video investigation is a vital segment of present-day metropolitan security, and when combined with computational examination, can have enormously extended usefulness including facial acknowledgment, movement recognition, traffic and group checking. This stands to identify the veil and social removing out in the open spots ,regardless of whether the individual wearing cover and keep up friendly separating or not .At present

restricted writing on exhibited compelling minimal effort frameworks for sending .In security and the executives areas ,there stay an extraordinary dependence on conventional manual checking of CCTV film using PC vision and ongoing mechanized investigation in substitution of difficult work lessens operational expenses as well as dispenses with human mistakes ,it tries to build up a biable arrangement prepared execution .numerous association today is anticipating adjust numerous fields have change their work way of life in computerized way thus ,continuous recognition frameworks are fundamental for such applications .we utilized different profound learning methods like yolov3 object identification.



Fig 1. Video analytics

II. LITERATURE REVIEW

[1]. Lalitha r, Sagayasree.z, et.al. (2020). inspect whether every individual is wearing face mask in public places. If it is not, the drone sends alarm signal to nearby police station and also give alarm to the public. The proposed system uses an automated drone which is used to perform the inspection process. the drone is being constructed by considering the parameters such as components selection, payload calculation and then assembling the drone components and connecting the drone with the mission planner software for calibrating the drone for its stability. The trained yolov3 algorithm with the custom data set is being embedded in the drone's camera. The algorithm can be embedded in public cameras and then details can be fetched to the camera unit same as the drone unit which receives details from the drone location details and store it in database.

[2]. Rucha visal, Atharva.T, et.al. (2020). emphasizes on a surveillance method which uses Open-CV, Computer vision and Deep learning to keep a track on the pedestrians and avoid overcrowding. implementation has been done using closed circuit television (CCTV) and Drones where the camera will detect the crowd with the help of object detection and compute the distance between them. The Euclidean distance between two people will be calculated in pixels and is compared with given standard distance and if it is observed to be less than the standard distance the local authorities or local police authorities will be notified.

[3]. George J Milne and Simon Xie (2020) evaluated a range of social distancing measures to determine which strategies are most effective in reducing the peak daily infection rate, and consequential pressure on the health care system. Simulation of virus transmission in this community model without interventions provided a baseline from which to compare alternative social distancing strategies. From this model-generated data, the rate of growth in cases, the magnitude of the epidemic peak, and the outbreak duration were obtained. The application of all four social distancing interventions: school closure, workplace non-attendance, increased case isolation, and community contact reduction is highly effective in flattening the epidemic curve, reducing the maximum daily case numbers, and lengthening outbreak durations. The most effective single intervention was found to be increasing case isolation, to 100% of children and 90% of adults. As strong social distancing intervention strategies had the most effect in reducing the epidemic peak, this strategy may be considered when weaker strategies are first tried and found to be less effective. Trade-offs may need to be made between the effectiveness of social distancing strategies and population willingness to adhere to them.

[4]. Sanjay Kumar.S, Sonali Agarwal, et.al. (2020) proposes a deep learning-based framework for automating the task of monitoring social distancing using surveillance video. The proposed framework utilizes the YOLO v3 object detection model to segregate humans from the background and Deep sort approach to track the identified people with the help of bounding boxes and assigned IDs. The results of the YOLO v3 model are further compared with other popular state-of-the-art models, e.g., faster region-based CNN (convolution neural network) and single shot detector (SSD) in terms of mean average precision (mAP), frames per second (FPS) and loss values defined by object classification and localization. From this analysis, it is observed that the YOLO v3 with Deepsort tracking scheme displayed best results with balanced mAP and FPS score to monitor the social distancing in real-time.

[5]. Alessandro Vinciarelli, et.al. (2017) introduce the Visual Social Distancing (VSD) problem, defined as the automatic estimation of the inter-personal distance from an image, and the characterization of related people aggregations. VSD is pivotal for a non-invasive analysis to whether people comply with the SD restriction, and to provide statistics about the level of safety of specific areas whenever this constraint is violated. The aim is to truly detect potentially dangerous situations while avoiding false alarms (e.g., a family with children or relatives, an elder with their caregivers), all of this by complying with current privacy policies. then discuss how VSD relates with Social Signal Processing and indicate a path to research new Computer Vision methods that can possibly provide a solution to such problem. the future challenges related to the effectiveness of VSD systems, ethical implications and future application scenarios.

[6]. Simon Ching Man Yu, et.al. (2019) presented a low-cost and efficient approach that integrates the use of computational object recognition to perform fully-automated identification, tracking, and counting of human traffic on camera video streams. Two software implementations are explored and the performance of these schemes is compared. Validation against controlled and non-controlled real-world environments is also demonstrated. The implementation provides automated video analytics for medium crowd density monitoring and tracking, eliminating labor-intensive tasks traditionally requiring human operation, with results indicating great reliability in real-life scenarios.

[7]. Dhananjay Kalbandeb, et.al (2020) propose a digital solution using Deep Learning technique which would alert them as soon as the violation of the social distancing is detected that is number of people more than the threshold (limit on the number of people allowed to be in a place, set by the government) or distance between two

people is less than the threshold distance. A video stream will be captured from the CCTV camera, with the help of Pose Net model we are detecting the humans and keeping a track of the number of humans present in the given live video stream, if the number of humans crosses the minimum threshold limit (set by the officials) or if the Euclidean distance between any two poses detected in the frame is less than say 3ft we alert the authorities in-charge. This application will save time and quick analysis as in layman's term the CCTV cameras will help simultaneously monitor each and every place of common gathering.

[8]. Li Wang and Dennis Sng (2015) Deep learning has recently achieved very promising results in a wide range of areas such as computer vision, speech recognition and natural language processing. Aims to learn hierarchical representations of data by using deep architecture models. In a smart city, a lot of data (e.g., videos captured from many distributed sensors) need to be automatically processed and analyzed. In this paper, we review the deep learning algorithms applied to video analytics of smart city in terms of different research topics: object detection, object tracking, face recognition, image classification and scene labeling.

[9]. Gayatri Deore, Ramakrishna Bodhula, et.al. (2016) we propose a technique for masked face detection using four different steps of estimating distance from camera, eye line detection, facial part detection and eye detection. The paper outlines the principles used in each of these steps and the use of commonly available algorithms of people detection and face detection. This unique approach for the problem has created a method simpler in complexity thereby making real time implementation feasible. Analysis of the algorithm's performance on test video sequences gives useful insights to further improvements in the masked face detection performance.

[10]. Chengyi Qu, Songjie Wang, et.al (2019) propose a dynamic computation offloading and control framework, named DyCOCO, based on image impairment detection under various available network bandwidth conditions. DyCOCO framework demo features IoT devices in a test bed setup on the GENI infrastructure. results show that our DyCOCO approach can efficiently choose the suitable networking protocols and orchestrate both the camera control on the drone, and the computation offloading of the video analytics over limited edge computing/networking resources.

III. OBJECTIVE

To examine whether individuals in a public spot keeps up friendly removing. It likewise checks whether each

individual is wearing face veil. The objective is to recognize occasions of semantic items that having a place with specific classes by applying profound learning method identifying human veil and actual distance is the necessities of this venture. It additionally checks every single distinctive individual. We assess scope of recognizing cover to figure out which methodologies are best in suffering in look every day by utilizing video Analytics. Social removing is characterized as keeping at least two meters (6 feet) aside from every person to dodge public contact. Further investigation additionally propose that social removing has significant monetary advantages. Coronavirus may not be totally dispensed with temporarily, yet a mechanized framework that can help observing and examining social removing measures can extraordinarily profit our general public.

IV. METHODOLOGY

A. Software Implementation

Our product bundle is executed on Python with the Open-Source Computer Vision (OpenCV) library. OpenCV upholds machine profound learning structures, and gives picture control, object ID, and movement following devices that are extraordinarily important for the advancement of programming in our unique situation.

B. Background Subtraction

Foundation deduction is essentially identifying moving items in recordings utilizing static camera. the fundamental is to distinguishing the moving articles from the distinction between the current casing and a reference outline, which is classified "foundation picture" or "foundation model". Foundation deduction is a strategy for isolating out forefront components from the foundation and is finished by creating a frontal area veil Background deduction method is significant for object following. In an external environment, flimsy environment, light changes, and reflections from surfaces on moving things would all have the option to decrease the limit of the reference layout allowance to separate establishment and closer view parts. The foundation picture should be adequate to address the scene with no moving articles and be routinely refreshed so it adjusts to the changing luminance conditions and math settings. Helpless foundation picture may bring about helpless foundation deduction results, since it is to be deducted with the current picture to acquire the eventual outcome. Carried out three foundation deduction calculations going from fundamental system used to condition of craftsmanship procedures. Some basic methodologies plan to amplify speed and restricts the memory prerequisites which produce a low exact yield like the "outline contrast" technique and other modern

methodologies expects to accomplish the most noteworthy conceivable exactness under potential conditions.



Fig 2. Background Subtraction

C.YOLO V3

It is the most recent variation of a famous item discovery calculation YOLO – You Only Look Once. YOLO works in the method of an item indicator as a blend of an finder and an recognizer. In PC vision draws near, a sliding window was utilized to search for objects at various areas and scales. Since this was a particularly costly activity, the angle proportion of the item was typically thought to be fixed. Early Deep Learning based item recognition calculations like the R-CNN and Fast R-CNN utilized a technique called specific to limit the quantity of bouncing boxes that the calculation needed to test. Another methodology brought Over accomplishment included checking the picture at numerous scales utilizing sliding windows-like systems done convolutionally. This was trailed by Faster R-CNN that utilized a Region Proposal Network (RPN) for distinguishing bouncing boxes that should have been tried. By cunning plan the highlights removed for perceiving objects, were likewise utilized by the RPN for proposing potential bouncing boxes hence saving a ton of calculation. YOLO then again moves toward the item location issue in a totally extraordinary manner. It advances the entire picture just a single time through the organization. SSD is another item discovery calculation that advances the picture once however a profound learning organization, yet YOLOv3 is a lot quicker than SSD while accomplishing truly equivalent precision. YOLOv3 gives quicker than Realtime results on a M40, Titanx or 1080 Ti GPUs. To start with, it isolates the picture into a 13×13 network of cells. The size of these 169 cells fluctuates relying upon the size of the info. For a 416×416 information size that we utilized in our analyses, the cell size was 32×32 . Every cell is then answerable for anticipating various boxes in the picture. For each bouncing box, the organization additionally predicts the certainty that the jumping box really encases an item, and

the likelihood of the encased article being a specific class. A large portion of these jumping boxes are killed in light of the fact that their certainty is low or in light of the fact that they are encasing a similar item as another bouncing box with high certainty score. This procedure is called non-greatest concealment.

V. MAJOR RESULTS

We are focused on giving imaginative, strategic advances that ensure individuals and networks. Implementing social separating measures while amidst a progressing worldwide pandemic is an upward fight that each district and business is confronting today. It has been sent to get ready associations to adjust to the new standard to encourage appropriate adherence to rules and keep each local area part protected and sound.

A. Meaning of Project

This task has pragmatic worth under the current setting of the COVID-19 pandemic. Pipeline is now fit for recognizing individuals with, without and inaccurately wearing covers with sensible exactness. For certain enhancements, we imagine that item can be utilized as a segment in a contact following framework. Item is likewise generally Computationally effective. The equipment limit for sending is low. This implies that item is less confined by financial plan or the degree of monetary improvement at the area of its organization and henceforth can arrive at more places where COVID-19 diseases present more danger to individuals.

B. Privacy Concerns

Profound learning models have weaknesses. While it is feasible to lead antagonistic assaults on our model in the event that it is conveyed, such assaults are impossible not reason immediate, actual mischief to individuals whose countenances are distinguished. It merits referencing that, with least upgrades, our model is equipped for remembering identified countenances (e.g., through a face acknowledgment profound learning system). This is a probably use case if our model is fused into a contact-following framework where facial-acknowledgment and putting away faces are required. Facial highlights are by and large considered to have some degree of protection. In such cases, we should execute counter estimates, for example, carrying out safe profound learning models, jumbling put away faces and putting our item behind a safe solid highlight ensure the put away human countenances.

VI. IMPLEMENTATION

A. Dataset

Veils assume a huge part in securing the soundness of people against infection spread in air, as is one of only a handful few safeguards accessible for COVID-19 without vaccination. Consequently, it is vital for us to identify whether an individual wear a cover and whether they wear accurately as a method for following the disease. As of now, information driven discovery and grouping models should be fitted with a dataset to work appropriately. Veil recognition and order dataset in this paper come from one of the most recent Face Mask Detection. This dataset is solid and steady for recognition and grouping models, that is, in each and every picture, there may be various focuses with various classes. This undertaking is the thing that Yolo structure intended for. Moreover, in light of this dataset, we additionally fabricated a less difficult dataset comprising of target cuts in the first pictures, to prepare and test Yolo-based characterization just models. In the preparation set, there are 3145 pictures, with 2546 with cover, 508 without veil, and 91 covers worn mistakenly. The above numbers disclose to us that the dataset is restricted in size and is extremely one-sided towards the "Wearing Mask" class.



Fig 3. Yolo

B. Video Processing

We use OpenCV imagine the expectation brings about recordings. OpenCV upholds perusing surges of recordings from outside gadgets and documents from the nearby document framework. Given a prepared model on a veil discovery dataset, we anticipate that the output of the model should contain at any rate the accompanying fields: A variety of pictures utilized in the expectation and a variety of forecasts produced by the model, of tuples of the accompanying organization (a) x, y directions of the upper left corner of the jumping box, standardized to picture width and tallness. (b) x, y directions of the base right corner of the bouncing box, standardized to picture width

and tallness. (c) a gliding point certainty levels (d) a number demonstrating the anticipated class A variety of name names the video source is perused as an inerrable stream of casings of pictures. Each casing of picture is passed into our model at their unique tallness and width (e.g., 1080 pixels wide, 1920 pixels high). Our model produces derivation results adjusting to the above design. We utilize the outcomes to draw the bouncing boxes, anticipating class names and certainty level for each recognized (face, face covers, face veils worn mistakenly) on this edge of picture. The drawn casing is then passed into a video encoder to be saved as a casing in the yield video. The outcome is another video with the above perceptions with MPEG-4 encoding.

The info video isn't altered in any capacity Processing recordings with OpenCV adds overhead to display expectation. The overhead comes from perusing outlines from the info video, drawing the perceptions and composing the attracted casing to the yield video. Model is very performant, accomplishing 2 edges for every second on a humble double center Intel Xeon CPU at 1920×1080 goal.

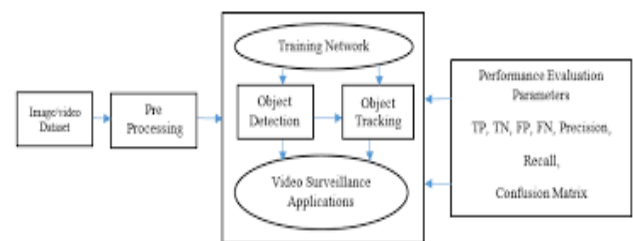


Fig 4. Block Diagram

VII. CONCLUSION

Real-time system to monitor the social distancing and using the proposed critical social density to avoid overcrowding. We are focused on giving imaginative, strategic advances that ensure individuals and networks. Implementing social separating measures while amidst a progressing worldwide pandemic is an upward fight that each district and business is confronting today. It has been sent to get ready associations to adjust to the new standard to encourage appropriate adherence to rules and keep each local area part protected and sound. This task has pragmatic worth under the current setting of the COVID-19 pandemic. Pipeline is now fit for recognizing individuals with, without and inaccurately wearing covers with sensible exactness. For certain enhancements, we imagine that item can be utilized as a segment in a contact following framework. Item is likewise generally Computationally effective. The equipment limit for sending is low. This implies that item is less confined by

financial plan or the degree of monetary improvement at the area of its organization and henceforth can arrive at more places where COVID- 19 diseases present more danger to individuals.

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Study of the effect of pre-existing crack and water saturation on strength of rock-like

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Keywords— *triaxial compression test, pre-existing crack, slope, strength.*

Abstract— *In civil and mining engineering works, the strength and rigidity of the rock mass can be affected by the existence of many kinds of discontinuities related to shear zones, faults, and bedding planes. This paper focuses on analyzing the effect of a single pre-existing crack on the strength and deformation behavior of rock samples based on the experimental results and to elucidate the influence of water on crack development. The triaxial compression tests were carried out on a variety of the rock samples constituted of a pre-existing crack with plane surface and rough surface with a variety of slope 30°, 45°, and 60° in the dry state and saturated state. Test data show that the existence of cracks promotes the lessening in the overall strength of the rock; though, the extent of the decrease of strength is associated with the rock properties. The lowest strength was detected for the samples with the greatest slope value. The influence of the fracture angle on the strength is independent of the drying and saturated environment of the rock mass. The strength and compressive behavior of the mass of fractured rock with different slopes under saturated conditions is lower than under drying conditions.*

I. INTRODUCTION

One of the most important aspects of rock mechanics is the study of the stability of underground excavations. Whether in the case of mining galleries, tunnels, or even oil drilling, the problem of work performance remains a major concern for industries for important reasons such as the safety and exploitation of these structures. The mechanical behavior of rock masses is a determining factor in the dimensioning of the structures which are executed there. This behavior is largely influenced by the presence of discontinuities. In order to understand, explain and model this behavior, it is necessary to know the geometric distribution model of fractures, as well as the mechanical properties of the rock and the discontinuities. The presence of discontinuities can significantly affect the mechanical behavior of the rock

mass by introducing weaknesses in terms of deformability and resistance [1, 2]. In the presence of discontinuities, the deformation modulus of the rock mass decreases remarkably compared to that of intact rock [3]. At shallow depth or in non-containment areas, such as excavations and civil engineering constructions, the deformation of the rock mass is essentially controlled by the presence of discontinuities while at depth or in areas with a high concentration of stresses, the influence of the structure is less marked [4,5]. In recent years, many scholars have analyzed the process of initiation and propagation of pre-existing cracks in rocks and other geological materials (rock-like for example) [6, 7, 8, and 9] and, the effects of this process on the rock's overall strength have been widely studied using uniaxial tests [10, 11, 12, 13, 14, 15, 16, 17, 18], biaxial tests [19, 20], shear and tension tests

[21, 22, 23, 24, 25]. Through these studies, it has been observed that under the load conditions, the pre-existing crack is at the origin of the appearance and the propagation of the majority of the new cracks which transform into rock bridges. The existence of relatively small rock bridges at the discontinuities greatly increases their strength [24, 25, 26] which must first be broken before a rupture can take place. The above-mentioned studies also pointed out that, the propagation of cracks within a rock was a complex phenomenon and depended on the rock composition and the properties (geometry/ shape, orientation, and size) of the pre-existing cracks.

There is still the uncertainty of predicting the effects of pre-existing cracks on rock strength characteristics despite a good understanding of the mechanism of crack propagation. Many authors [14, 26, 27] have noted that the strength of the rock can be affected by the characteristics of the joints such as the number of joints and their orientation. The strength of rock and rock mass can also be influenced by the roughness of the joints and the friction of the filled material [1, 27].

This work aims to examine the influence of pre-existing cracks of plane and rough surfaces on the strength of rock-like material and clarifying the effect of water on the propagation of cracks.

II. SAMPLE DESCRIPTION AND EXPERIMENTAL PROCEDURES

2.1 Sample preparation

Faced with the difficulty of collecting natural rock samples with the same shape and same rough or plane surface, the method of artificially creating joints is usually used to obtain samples corresponding to the programmed experiment. There are several methods of creating artificial rock samples, but the cement mortar method has been used from this experiment in order to conceive a batch of artificial joints with the same inclination angle of the pre-existing crack and the same shape of the surface. Cylindrical samples were used in the test; the specimen has consisted of a mixture of water, fine sands which particle size 2 mm-0.5 mm, and Portland cement with a ratio of 1:2:3. The specimen size is 50 mm in diameter and 100 mm in length ($\Phi = 50 \text{ mm} \times 100 \text{ mm}$). A fracture was created in the rock samples from a three-dimensional printed model using a 3D printer. The 3D model was put on the mold and the mixture then was filled into the mold for 24 hours. The 3D model placed in the mold permitted to obtain the different surface shapes (plane and rough surface) and values of the inclination angle (30° , 45° , and 60°).

The specimens took out from the mold and were kept in water for 28 days to increase the stability of the samples. This paper conducted two scenarios of the specimen which were plane and rough surface of the preexisting crack with a slope of 30° , 45° , and 60° . After creating the fracture, the rock sample is shown in figure 1.

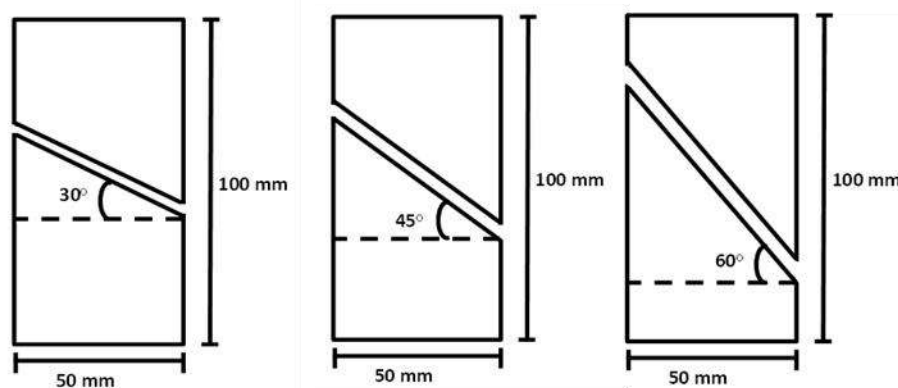


Fig.1: Specimen Slopes of 30° , 45° , and 60°

2.2 Triaxial compression test

The tri-axial compression test is administered on rock samples with a single pre-existing crack to determine the compressive strength of the rock.

This experiment uses the YAW-3000 microcomputer-controlled electro-hydraulic servo pressure testing machine

of the School of Mining and Engineering, Taiyuan University of Technology, and this testing machine was created by American AD company electronic devices. The test equipment required for inspection is an upgrade of the manual loading type and manual loading digital display universal testing machine currently in production and use. The tester uses a wide range of speed regulation ranges of

electro-hydraulic proportional valve group and computer digital control to form a fully digital closed-loop speed control system. It can automatically and accurately measure and control the whole process of loading and unloading of the tester., Wide control range, multiple functions, all operation keyboards, various test parameters are controlled, measured, displayed, processed, and printed by the computer, high integration, reliable to use. It can perform compression and various combined waveform tests on various metal and non-metal materials. It is

advanced testing equipment required for scientific research production and arbitration inspection. The maximum axial pressure and the maximum confining pressure of the tri-axial test system are 3000KN and 70 MPa, respectively. At constant flow, the injection of fluid can reach a maximum of 30 ml/min. The maximum pore water pressure is 40 MPa.

It has been applied a compression load with an increase of 0.5 kN / s until the sample is destroyed, and the test results of the relevant samples are presented in Table 1.

Table 1 test results of drying and saturated samples

	The samples serial number	Angle (°)	diameter (mm)	length (mm)	The compressive strength (MPa)	The largest load (KN)
Drying state	PDS01	30°	50.00	100.00	72.79	151.54
	PDS02	45°	50.02	100.01	34.18	53.29
	PDS03	60°	50.00	100.02	19.49	38.62
	RDS01	30°	50.01	100.00	70.55	132.46
	RDS02	45°	50.01	100.00	46.69	90.84
	RDS03	60°	50.00	100.01	39.72	82.14
Saturated state	PSS01	30°	50.00	100.00	51.69	84.08
	PSS02	45°	50.02	100.00	34.43	72.52
	PSS03	60°	50.00	100.01	17.57	41.14
	RSS01	30°	50.00	100.02	53.71	124.71
	RSS02	45°	50.01	100.00	41.89	88.99
	RSS03	60°	50.00	100.01	32.05	78.04

III. RESULTS AND DISCUSSION

3.1 Stress-strain analysis of drying samples

The typical stress-strain behavior observed in this study on samples with a pre-existing crack through the test results obtained are shown in Figure 2 for samples with plane surface and Figure 3 for samples with a rough surface. As can be seen in Figure 2, the sample with the slope of 30 ° has higher break stress 72.79 MPa compared to the samples with a slope of 45 ° and 60 °. The sample with a slope of 45 ° has reached a strength value of 34.18 MPa while the sample with the largest pre-existing crack slope of 60 ° has the lowest strength of 19.49 MPa.

However, for specimens with a rough surface with a pre-existing crack (figure 3), a significant increase in strength is observed by an average of 39.72 MPa for specimens with a slope of 60 °, an average of 46.69 MPa for those with a slope of 45 ° and greater strength of 67 MPa for

specimens at 30 °. This difference characterized by a change in strength values can be explained by the stress behavior related to the surface property of the pre-existing crack of the rock. The figures show that the rough surface has higher compressive strength than the plane surface except for the specimen with a slope of 30 ° in the dry state for this scenario. It can be generally concluded that rough surfaces resist the load better than plane surfaces.

According to the curves obtained in Figures 2 and 3, we can also note that the inclination angle of the pre-existing crack can influence the behavior of the samples. Regardless of the shape of the pre-existing crack surface, the specimen having the smallest value of the slope (30 °) presented a higher strength (72.79 and 67 MPa) while the specimen with the greatest value of the slope (60 °) presented the lowest resistance (19.49 and 39.72 MPa respectively) that is in the saturated state or the dry state.

The results of figure 2 also indicate that a rise in the slope value of the crack decreases the strength of the samples.

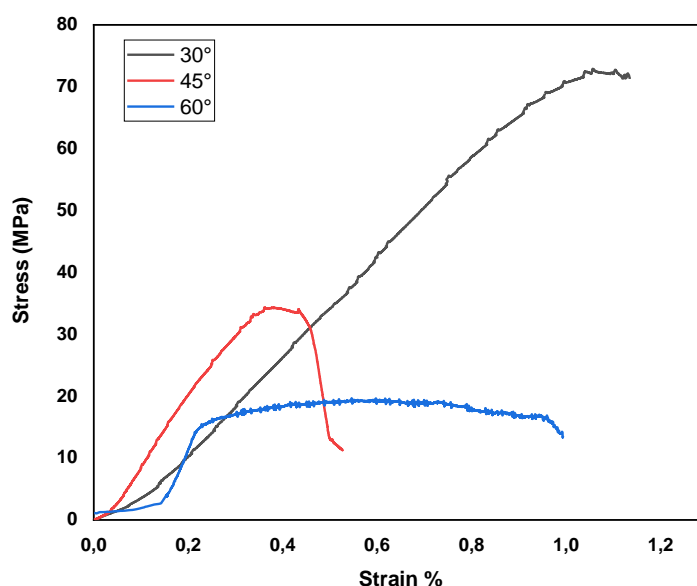


Fig.2: Experimental stress-strain curves for drying state specimens with plane surface.

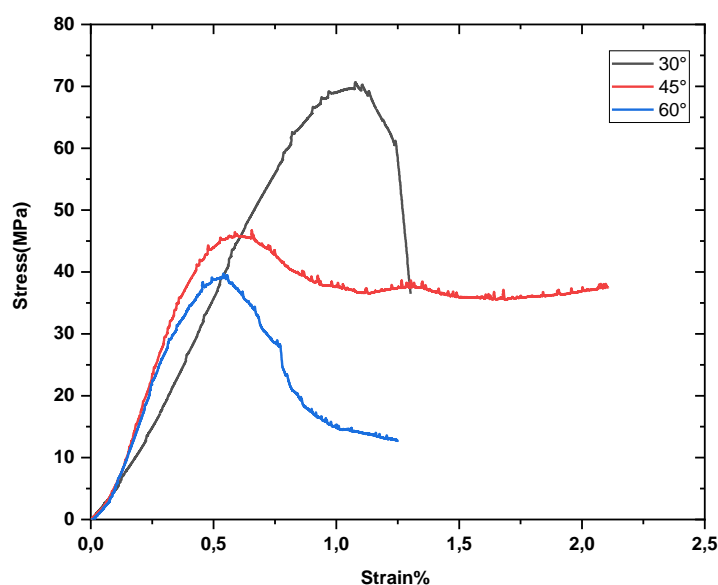


Fig.3: Experimental stress-strain curves for drying state specimens with rough surface.

3.2 Stress-strain analysis of saturated samples

The test results obtained for the samples in the saturated state are given in Figures 4 and 5, respectively. As shown in Figure 4 obtained from the test results, the samples with plane surface indicated that the sample at 60 ° produced a lower resistance 17,57 MPa compared to the

sample of 45 ° with a value of 34,43 MPa and the sample at 30 ° which has a higher strength 51,69 MPa.

The same characteristics were observed for the samples with a rough surface. The sample with the 30 ° slope exhibited maximum strength with a mean stress value of 53,71 MPa, whereas the sample with the slope of 60° obtained the lowest strength with a stress value of 32,05

MPa. The samples with rough surfaces have undertaken higher deformations, generating larger stresses at failure,

while brittle behavior has been observed in samples with plane surfaces under high loads.

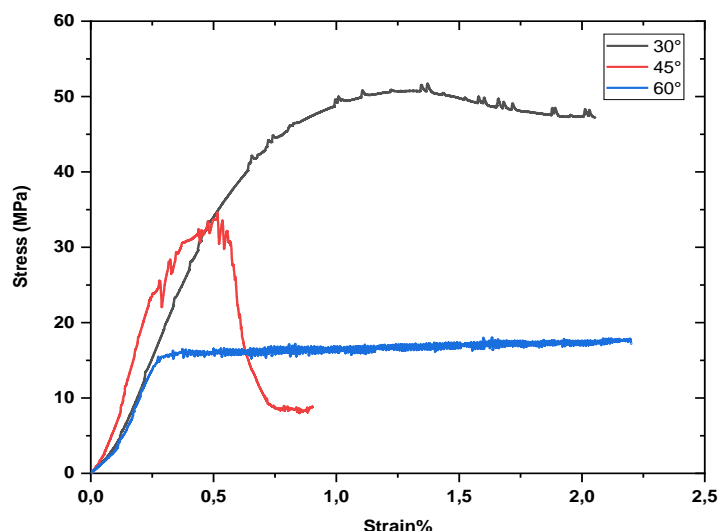


Fig.4: Experimental stress-strain curves for saturated state specimens with plane surface.

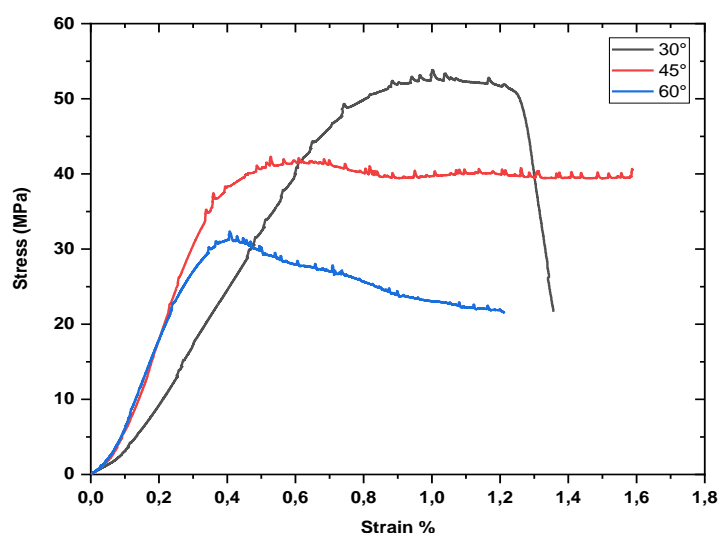


Fig.5: Experimental stress-strain curves for saturated state specimens with rough surface.

3.3 Failure patterns

The fracture mechanism behavior of the rock specimens is essentially constituted by a dynamic process, this process is constituted by different phases that are: initiation, propagation, coalesces of cracks, and finally failure.

Depending on the properties of the rock sample and the presence of grains, the grains have an influence on the propagation behavior of cracks by making the crack

surface irregular on sliding and conduct the propagation of cracks lengthways of the specimen following a twisted pathway.

The sliding model estimates that under the compressive load of the model material, the shear stress at the crack surface will cause part of the rock mass on the crack to slide down, and the normal stress acting on the crack surface will consequently generate friction to prevent the upper part of the rock mass from moving down

so that it can be seen that there is friction between the two fracture surfaces.

From the relationship between friction resistance and shear force, it can be known that the effective shear stress on the crack surface is the cause of micro-cracks at the germination of the crack top. Therefore, under different fracture dip angles and different rock bridge lengths, the effective shear stress component along the fracture surface will directly affect the initiation and expansion of cracks at the crack top of the specimen.

Observations and analyzes of the images of the samples after testing were made and shown certain resemblances in the fracture pattern of the samples with diverse characteristics of pre-existing cracks. For the majority of samples, regardless of the type of surface, it was observed the appearance of new cracks which subsequently propagated throughout the sample leading to ruptures (as shown in Figure 6), unlike the samples with a higher slope, exhibited a distinct behavior under high stress.

It was observed that for all rock samples with a slope of 30° regardless of the shape of the plane or rough surface, the appearance of new cracks at the level of the pre-existing crack (as presented in Figure 6a). Subsequently, these cracks propagated (Figure 6b) through the entire sample causing failure (shown in Figure 6c). The

analysis of the crack propagation model of rock samples with the rough surface was made with difficulty because, during the experiment, some samples (30°) did not slide along the surface of the joint, but broke under the action of axial pressure; as a result, the joint surface was severely damaged.

Specimens with pre-existing cracks with a 45° slope failed in different ways. It was observed for the sample with a rough surface, the formation of new cracks which formed near the preexisting single crack, then propagated along with the sample, causing a failure shown in figure 7a. This is contrary to the samples with a plane surface presenting some special cases where new cracks did not occur at the level of the pre-existing crack or hardly at all, see figure 7b.

Concerning the samples presenting a single preexisting crack with a slope of 60° , similarly to 45° , the rock samples with plane surface did not show new cracks near the preexisting crack but by account, it was observed the presence of a new crack near the pre-existing crack for the rough rock sample that only developed on one of the sample halves (Figure 8). The new discontinuities developed through the samples at 30° and 45° are greater than those at 60° , so we can conclude that the greater the slope, the less we observe new cracks.

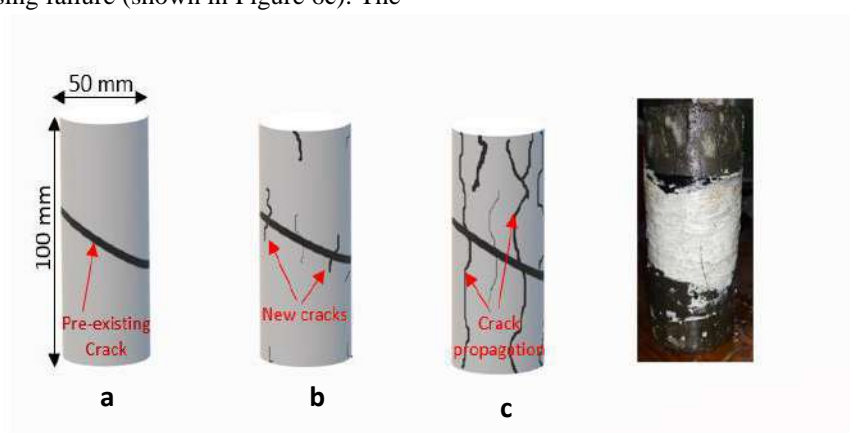


Fig.6: Initiation and propagation of cracks in the specimen with 30°

Typical failure patterns of specimen with 30°

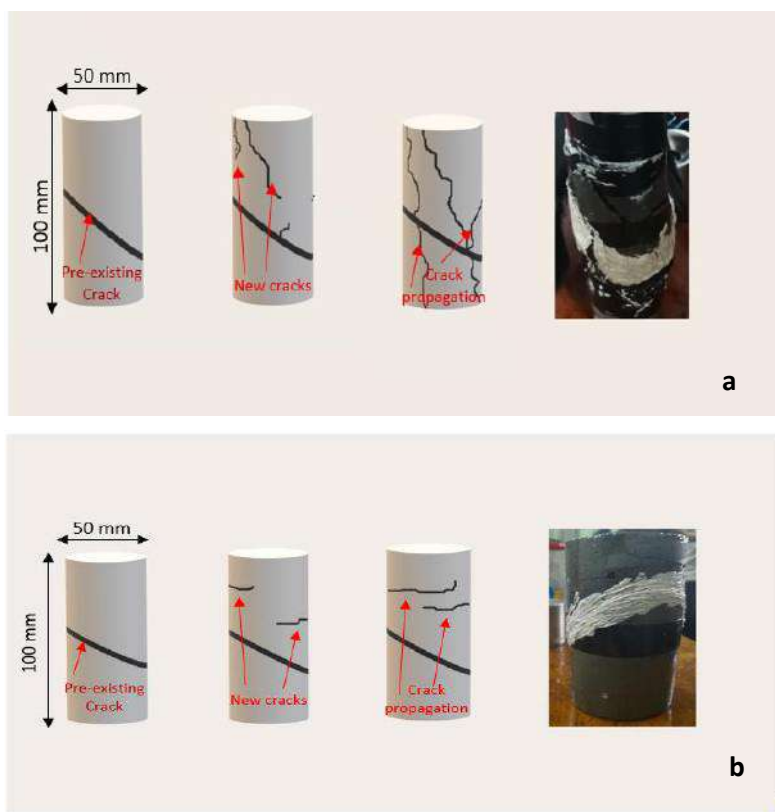


Fig.7: Typical failure patterns of specimen with 45°, rough surface(a)plane surface (b).

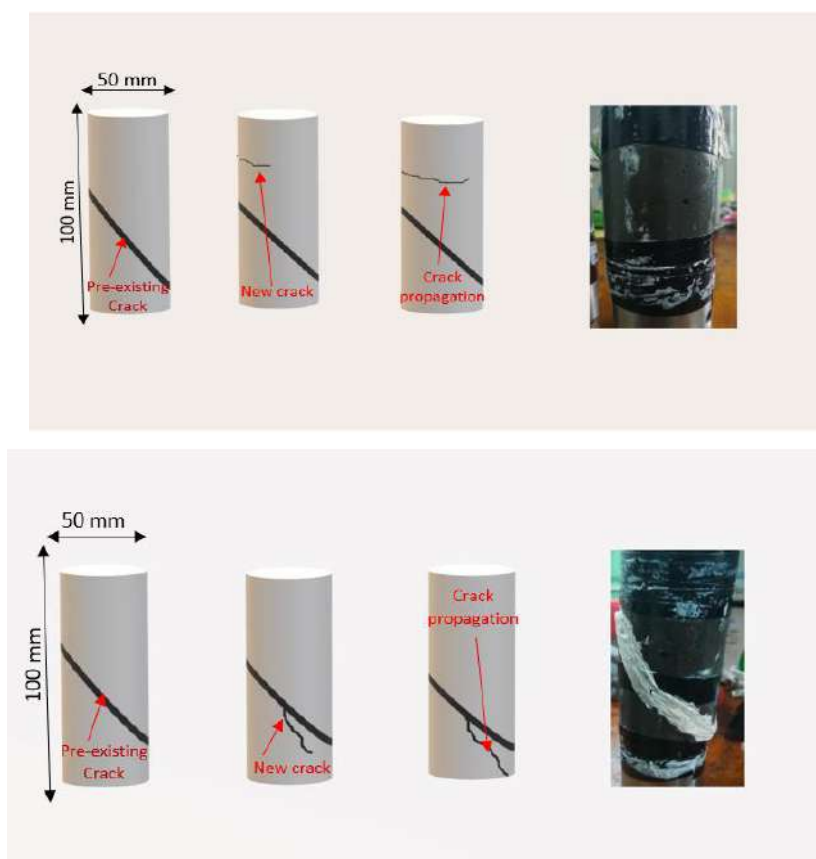


Fig.8: Typical failure patterns of specimen with 60°

3.4 Effect of water on rock behavior

To further analyze the effect of water saturation on the rock behavior, a sample batch has been drained before the test in order to saturate and reduce the infiltration time of our samples. A visualization analysis was performed on the faces of the sample containing the pre-existing crack after the test for better understanding.

By making a comparison between saturated and dry samples, there has been a difference in failure behavior. The water saturation failure of rock specimens takes into account the specimen of rock concerned and its properties, such as the topological structure, roughness of the crack surface, surface humidity, and adsorption and desorption properties, fissures of pore media and distribution of pores, wetness spreading and particulars of spreading of various stages.

The presence of the cracks and the porosity of a rock mass-produce an important role in rock mechanics, the distribution of pores and cracks of pores promote the circulation and the weakening influence of water on rock strength (the influence of water weakening). The presence of water in rock specimens in the saturated state reduces the strength of specimens, causing the specimens to be easier to damage, and the brittleness of specimens is lowered. For this reason, the rock specimens in the saturated state are easier to fail. It is important to note that except the strength of the specimen, the effect of the water affects too the failure process.

Figures 9, 10, and 11 show the failure behavior of the rock specimens in the saturated state under the compressive load. However, concerning the processes of failure of samples with a slope of 30° , the cracks observed on the saturated rock sample are more visible than the cracks observed on the drying sample. Also, we can

observe from Figure 9b that the new cracks observed at the pre-existing crack develop and penetrate in the sample, dividing almost the sample into several halves, which is not similar for the sample in the drying state Figure 9a. By following the sliding plant, the upper part of the drying state has submitted fewer new cracks but more visible compared to the lower part of the sample while the new cracks observed on both parts of the saturated state sample are almost identical. The observation is the same for the saturated rough samples where the new cracks are more visible and propagate more than those in the drying state.

For samples with a slope of 45° , it was observed the appearance of new cracks at the pre-existing crack for saturated state samples and subsequently propagated on both halves (upper and lower parts) of the sample Figure 10b. Unlike the drying state samples that have a particular case where new cracks have been observed only on one of the halves of the sample and do not start at the pre-existing crack and are shown in Figure 10a.

Concerning the samples with a slope of 60° , similarly to the samples with a slope of 45° , it was observed the absence of the new cracks at the pre-existing crack for the samples in the drying state Figure 11a. While it has been noted the presence of new cracks near the pre-existing fissure and propagated just on one of the halves of the sample for saturated samples Figure 11b. The new discontinuities that appeared on the samples with a slope of 60° are less visible compared (by comparison) with samples with slopes of 30° and 45° slope.

By making a comparison between the saturated state specimens and those in the dry state, it can be seen that water saturation has a particular effect on the strength of rock specimens in the saturated state.

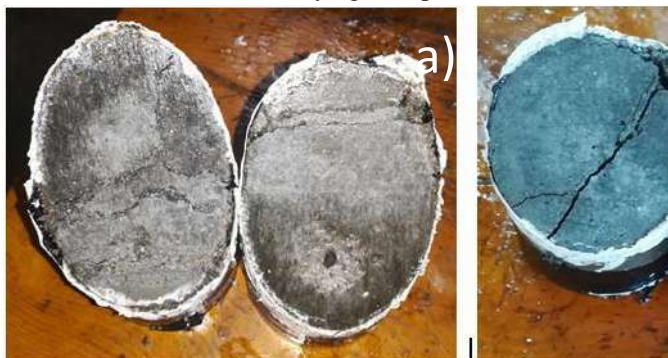


Fig. 9: Failure patterns observed in specimens with 30° a) drying state b) saturated state

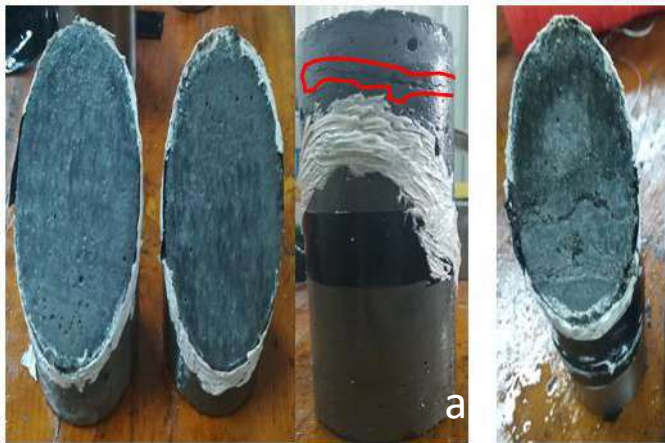


Fig.10: Failure patterns observed in specimens with 45° a) drying state b) saturated state

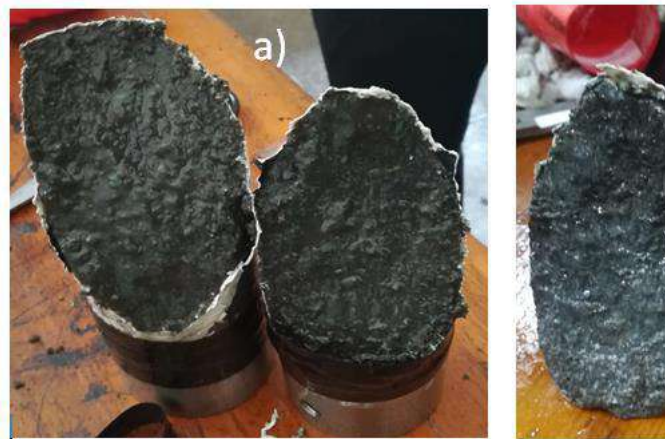


Fig.11: Failure patterns observed in specimens with 60° a) drying state b) saturated state

IV. CONCLUSIONS

To better understand the pre-existing crack effects of rock specimens, a series of triaxial compression studies are made on specimens of rocks containing a plane surface and rough surface in the drying state and saturated state with a variation of inclination. The influence of the inclination, strength, the failure model, and the typical effect of water on the development of cracks are analyzed and discussed. The principal conclusions are as follows:

Regardless of the type of specimen, the pre-existing crack decreases the strength of the rock. The variation of the inclination angle of the fracture affects the compressive strength of the fractured rock mass and is independent of the dry or wet environment.

The maximum and minimum failure loads are obtained at an inclination of 30° and 60°, respectively. Under compressive load conditions, the specimens with a slope of 30° were destroyed when the test force applied to the

sample reached its maximum due to the appearance and propagation of new cracks.

Further compressive strength of drying state specimens performed better than the saturated state.

It can be said that the damage to the sample is mainly affected by the texture of the surface of the fracture because the rough surface samples resist the load better than the flat surface samples.

The flow of water in the rock mass is one of the parameters that considerably affected the behavior, resistance, and stability of specimens. The presence of water pressure in the fractures increases, on the one hand, the active forces on the sliding of the blocks and decreases, on the other hand, the normal stresses and the resistance on the slip planes. New cracks that started at the pre-existing crack dominated the failure process.

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Material and Energy Balance Analysis for Urea Production from Biomass via Methane Steam Reforming

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Keywords— Balance Energy, Biomass, Biogas, Urea.

Abstract— The urea industry often requires the use of fossil fuels or natural gas. This study raises the possibility of producing urea from biogas, a more environmentally friendly alternative. The purpose of this work is a block flow diagram for a passage process; also, the material in terms of molecular flow and energy balances has been resolved for some process units, considering the main theoretical chemical reactions that are involved in these processes. From the material balance analysis, it is possible to estimate a biogas ratio for urea of 14.8. Thus, it is possible to verify the relevance of the recovery and reuse of non-reactive products for increasing urea production. Therefore, the energy balance analysis, the endothermic and exothermic characteristics of the chemical reactions involved are necessary to estimate the thermal load of each unit studied.

I. INTRODUCTION

Urea is an essential product in agriculture due to its nitrogen (46%), necessary to cultivate roots, sprouts, and fruits of plants. Thus, all fertilizer produced consumes approximately 90% of the Urea (SERGEEV et al., 2020).

Three process steps are the main routes for urea synthesis. They are: (1) decomposition of methane gas (CH_4), under high temperatures, into hydrogen (H_2), carbon monoxide (CO), and carbon dioxide (CO_2); (2) reaction between hydrogen formed and nitrogen (N_2) to synthesize ammonia (NH_3) and finally (3) the reaction between ammonia and carbon dioxide (CO_2) to form ammonium carbamate ($\text{NH}_2\text{COONH}_4$) and decomposed into urea ($(\text{NH}_2)_2\text{CO}$) and water (H_2O) (DAVEY et al., 2010).

The gas mixture composed of H_2 and CO , resulting from methane decomposition, is known as synthesis gas (syngas). It is the only economically viable route for converting methane into a higher added-value chemical product. Among the chemical ways for obtaining syngas are (a) steam reform, (b) dry reform, and (c) partial oxidation (YORK et al., 2003).

Syngas, ammonia, and urea production often originate from coal or natural gas with other materials and CO_2 (GUO, 2013). The present work reinforced the use of biogas, a gaseous mixture rich in CH_4 and CO_2 produced by bacterial decomposition of organic wastes, as a plausible feedstock for urea obtention.

The stimulation of biogas production is essential since methane is one of the significant constituents of biogas.

Also, since methane is one of the greenhouse gases, its use for hydrogen production is beneficial. The first step in the synthesis of urea reduces environmental impacts. Still, it offers an efficient destination for using this resource (biogas), with the advantages of having low cost and excellent availability (CHAO et al., 2008).

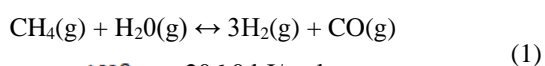
Thus, this work proposes a better understanding of urea's production from biogas through a process block flowchart. This flowchart aims to simplify and facilitate understanding of this process's basic structure and demonstrate the realization of the fundamentals of material flow analysis (molecular) and energy balance. These tools represent a gold standard feature of chemistry. Also, to processing systems and playing an essential role in efforts to support operational plants.

II. GENERAL DESCRIPTION OF THE PROCESSES

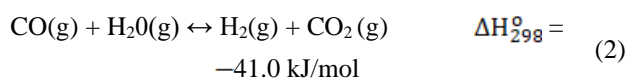
A. Methane Steam reforming

The first patents on steam methane reform (SMR) date back to 1926, with the first reform plant built in the 1930s. However, large-scale production only started in the 1960s, following the discovery of large fields of gas in Europe, which made it possible to change the raw material from coal to natural gas, and today, the SMR method is responsible for 80% - 85% of global hydrogen production (KOROBITSYN et al., 2000; ALHAMDANI et al. 2017).

Two main reactions can describe the steam methane reforming (SMR) process. (Eq. 1 and Eq. 2) (KOROBITSYN et al., 2000):



$$\Delta H_{298}^{\circ} = 206.0 \text{ kJ/mol}$$



The first reaction (Eq. 1) is the reform reaction itself, while the second reaction (Eq. 2) is known as the water-gas shift reaction (WGS). SMR is an endothermic reaction and requires steam as an oxidizing agent to produce syngas with an H_2/CO ratio of 3 (Eq. 1). Despite the stoichiometric reagent ratio $\text{H}_2\text{O}/\text{CH}_4$ of 1, steam is usually fed in excess with $\text{H}_2\text{O}/\text{CH}_4$ ratio around 2.5–3 (VASCONCELOS & LAVOIE, 2018).

The steam reform reaction is favorable at high temperatures and low pressures. At first, reforming proceeded at atmospheric pressure, but, as it was found that increased pressure can save compression energy in the downstream synthesis stage, Process conditions are

increased to pressures up to 30 bar and temperatures up to 1000°C (KOROBITSYN et al., 2000). ZHOU et al. (2011) studied thermodynamic equilibrium models for methane reforming processes and found that steam reforming is not favorable at temperatures less than 630 °C and from their models, it was also shown that CO and H_2 production reach a maximum near 850 °C, which is also the CH_4 maximum conversion.

Following the SMR, the H_2 / CO ratio of the synthesis gas produced can be increased utilizing the water-gas displacement reaction (WGS) at lower temperatures. Besides, carbon monoxide is converted to carbon dioxide, which can be used later in the synthesis of Urea (Vasconcelos & Lavoie, 2018; COPPLESTONE & KIRK, n.d.).

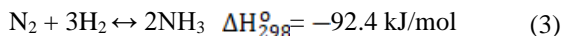
Regardless of being a well-established technology, several studies propose improvements for the methane steam reforming process, including catalysts (MORAL et al., 2018; AMJAD et al., 2019; KATHERIA et al., 2019) and process designs (EYALARASAN et al. 2013; KHUSAIBI & RAO, 2016; NGUYEN et al., 2019). Such studies play a significant role in the achievement of reforming plants with lower investments and operational costs (FERREIRA-APARICIO et al., 2005).

Among the suggestions is using a novel feedstock instead of coal and natural gas for hydrogen generation. In that respect, the anaerobic bacterial digestion of different residual streams (e.g., wastes in landfills) allows the obtention of a methane-rich gas called biogas. Biogas is mainly applied for heat and power generation employing its direct combustion. However, the interest in the valorization of landfill biogas has led to its use to produce valuable chemicals of industrial relevance. Thus, the biogas conversion into syngas could be considered to develop such valorization technology (MORAL et al., 2018).

Raw biogas composition often corresponds to the fraction of 40-75% of methane (CH_4); 15-65% of carbon dioxide, and trace amounts of other gases as hydrogen sulfide (H_2S), carbon monoxide (CO), hydrogen (H_2) and nitrogen (N_2). From those components, H_2S must be removed since it is a toxic and corrosive gas. Thus, biogas' desulphurization is a requirement for its use for energy and hydrogen generation (RYCKEBOSCH et al., 2011). According to Moral et al. (2018), It can apply several alternatives to provide raw biogas for its further use as raw material for producing biofuels and or chemicals. Regarding H_2S removal, Ryckebosch et al. (2011) review distinct methods such as biological filter, membranes, and chemical absorption, reaching 100% removal efficiency.

B. Ammonia Synthesis

One of the reagents for urea reaction synthesis, ammonia (NH_3), has been known for over 200 years when it was first isolated in gaseous form, in 1774, by the English chemist Joseph Priestley. Nevertheless, the feasible reaction for producing commercial quantities of ammonia was first described by the German chemist Fritz Haber, that synthesized ammonia in the laboratory from N_2 and H_2 (PATTABATHULA & RICHARDSON, 2016), as shown in the reaction (Eq. 3):



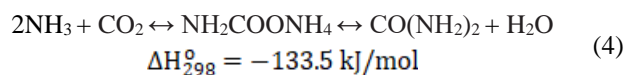
Usually, the reaction occurs on an iron catalyst with pressure in the range of 150 to 250 bar, and temperatures in 350 °C to 550 °C. Moreover, at the usual common reaction operating conditions, the conversion achieved per pass is limited from 20% to 30%; consequently, the precise removal of synthesized ammonia is essential. It is accomplished via mechanical refrigeration or absorption/distillation (MAXWELL, 2004).

Most of the global production of ammonia is based on steam reforming of natural gas (PATTABATHULA & RICHARDSON, 2016), and it has a direct impact on the costs for ammonia production since natural gas prices can vary according to many factors (e.g., region and government controlling) (MAXWELL, 2004). In this sense, many studies in recent years have recognized the potential of ammonia production from the biomass gasification route (ARORA et al., 2016), supporting the use as mentioned above of biogas to hydrogen generation.

C. Urea Synthesis

The commercial production of urea is based on the reaction of ammonia (NH_3) and carbon dioxide (CO_2) at high pressure (150 to 160 bar) and temperature (180 °C to 190 °C) to form ammonium carbamate, which is dehydrated into urea and water, according to the reaction described in Eq. 4. Such reaction (Eq. 4) was discovered

in 1868 by a Russian chemist, Alexander Ivanovich Bazarov. Nowadays, global urea production reaches 229 million tons/year (SOLIMAN, 2019; MAXWELL, 2004; SERGEEV et al., 2020).



The synthesis of urea is purely a thermal reaction and does not require any catalyst (MacDOWELL et al., 2010). The ammonium carbamate formation is fast, highly exothermic, and goes essentially to completion under normal industrial processing conditions, while urea formation is slow and endothermic. Moreover, ammonia is usually feed in excess, and therefore the reaction conversion is described in terms of carbon dioxide reacting percentage (SOLIMAN, 2019).

The significant difference among the existing urea production technologies is how urea is separated from the reactants and how ammonia and carbon dioxide are recycled. Concerning the urea separation, the urea solution prevented from the synthesis reactor must be concentrated to a urea melt for conversion to a solid piled or granular product. (MAXWELL, 2004).

III. PROCESS BLOCK FLOW DIAGRAM FOR UREA PRODUCTION FROM BIOGAS

The above-mentioned theoretical approach of the three steps for urea production is proposed a short process flow diagram for urea production from biogas. In addition, material and energy balances involved in such a process are estimated, aiming to add to the development of such potential methods and improve process efficiencies.

The proposed process block flow diagram for such a process is presented in Fig. 1.

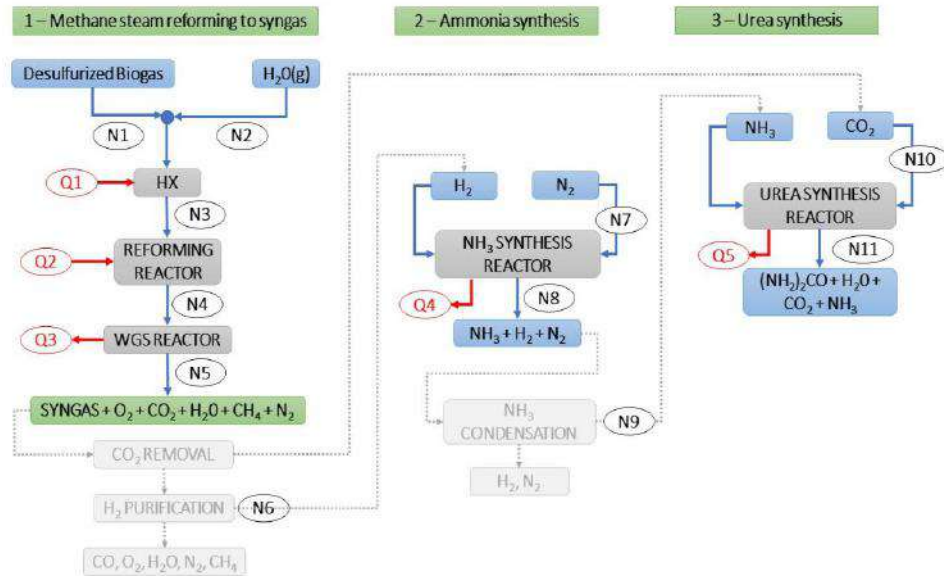


Fig.1: Brief process block flow diagram to produce urea from biogas. The molecular flows are represented by the letters "N," and the heat flows are represented by the letters (Q).

From Figure 1, the proposed block diagram for urea production from biogas is a three steps process. At the first step, saturated steam and methane streams are mixed and preheated in a heat exchanger (HX) before flowing into the reforming reactor. At the outlet reform reactor, the produced steam of gases is directed to the water-gas shift reactor. Then the gases of interest (H_2 and CO_2) leaving the WGS reactor must be purified to be used at further steps. The non-reacted reagents at the end of step 1 (CH_4 and H_2O) can be reutilized after cleansing. At the second step, hydrogen purified from step 1 reacts with nitrogen to yield ammonia (NH_3). At the third step, the ammonia separated from step 2 reacts with carbon dioxide (CO_2) (which part of the necessary amount was produced at step 1) to solve molten urea.

A. Molecular Species and Energy Balances

Material balances are essential to support a process design since they can determine the quantities of raw materials required and products produced in stream flows and compositions. The material balance for any process, given by the mass conservation law, can be written as shown in Eq. 5 (CLARK, 2009):

$$\frac{d}{dt}(VC_{sys}) = \sum_{i=1}^N F_{in,i} C_{in,i} - \sum_{j=1}^M F_{out,j} C_{out,j} \quad (5)$$

F Values are mass flows going into or out of the system; C values are mass concentrations of some component of

interest; V is the volume of the system, C_{sys} is the average concentration of the component of interest in the system.

Considering steady-state conditions, the time derivative in Eq.5 is equal to zero, and QC values are constants. Hence, Eq. 5 turns into Eq. 6:

$$\sum_{i=1}^N Q_{in,i} C_{in,i} = \sum_{j=1}^M Q_{out,j} C_{out,j} \quad (6)$$

For systems involving chemical reactions, a molecular balance for each species should be done, considering the terms of consumption and generation. Thus, the general molecular balance equation for a reactive steady-state system is given by Eq. 7:

$$\text{input} + \text{generation} = \text{output} + \text{consumption} \quad (7)$$

From the proposed process block flow diagram for urea production from biogas (Figure 1), desulphurized biogas is the process feedstock. Thus, to realize molecular balance, it is

Table 1. Biogas composition considered for the study

Species	mol Fraction, Y_i (%)	MM (kg / k mol)	Biogas MM* (kg / k mol)
CH_4	56.00	16.04	8.98
CO	3.00	28.00	0.84
CO_2	37.00	44.01	16.28
N_2	1.00	28.01	0.28

H ₂	1.00	2.02	0.02
O ₂	2.00	32.00	0.64
TOTAL	100.00	-	27.05

*MM = MOLECULAR MASS

Besides biogas composition, some reasonable assumptions important for molecular balance were taken: (a) H₂O/C ratio for steam reform reaction equal to 4 (SHAGDAR et al., 2020); (b) methane conversion at steam reform reaction equal to 90% (SHAGDAR et al., 2020); (c) H₂ conversion at ammonia synthesis reaction equal to 26% (MAXWELL, 2004); (d) CO₂ conversion into urea equal to 60% and NH₃/CO₂ ratio for urea synthesis of 2,95 (MAXWELL, 2004).

Given the concepts and assumptions for molecular balance applied in the present study and knowing that molecular flow determination plays an essential role in the energy balance, the current work's energy balance concepts and beliefs are now presented.

Energy balance equations were used to confirm the first law of thermodynamics for each system of the blocks presented in Fig. 1 as a control volume under the steady-state operation. From the first law of thermodynamics, the energy balance for a stationary open system with no kinetic, potential energy, and volume variation is given by:

$$\dot{Q} = \Delta \dot{H} = \dot{n}_{output} x \hat{H}_{output} - \dot{n}_{input} x \hat{H}_{input} \quad (8)$$

\dot{Q} Value is the heat transfer rate going into or out of the system, \dot{n} and \hat{H} values are the molecular flow and specific enthalpies of the components going into (reagents) and out (products) of the system, respectively.

Specific enthalpy values for each component at the inlet and outlet streams of each process were calculated taking into consideration the relationship between the standard enthalpy of formation (ΔH_f°), heat capacity (C_p), and temperature (T) variation:

$$\hat{H}_{specie} = \Delta H_f^\circ + \int C_p dT \quad (9)$$

Finally, heat capacity (C_p) values for each component at the inlet and outlet streams were estimated as described in Felder (2016), as presented in Eq. 10, and the

coefficient values, as well as standard enthalpy values, are shown in Table 2 (Felder, 2016).

Table 2. Coefficient values for heat capacity equation and Standard Enthalpy of Formation (ΔH_f°)

Species	a	b	c	d	ΔH_f° (kJ/mol)
CH ₄	3.43E-02	5.47E-05	3.66E-09	-1.10E-11	-74.84
CO	2.90E-02	4.11E-06	3.55E-09	-2.22E-12	-110.52
CO ₂	3.61E-02	4.23E-05	-2.89E-08	7.46E-12	-393.51
N ₂	2.90E-02	2.20E-06	5.72E-09	-2.87E-12	0
H ₂	2.88E-02	7.65E-08	3.29E-09	-8.68E-13	0
O ₂	2.91E-02	1.16E-05	-6.08E-09	1.31E-12	0
H ₂ Oliq	7.54E-02	-	-	-	-285.84
H ₂ Ogas	3.45E-02	6.88E-06	7.60E-09	-3.59E-12	-241.83
NH ₃	3.52E-02	2.95E-05	4.42E-09	-6.69E-12	-67.20
(NH ₂) ₂ C O	9.00E-02	-	-	-	-333.39

The temperature is Celsius °C.

IV. RESULTS AND DISCUSSIONS

A. Molecular balances

Table 3 shows the molecular flow in the inlet and outlet streams of the steam reforming reactor. As it can be seen, it was established 1 mol of methane (corresponding to 1.77 mol of biogas) and four mols of water vapor

flowing into the system. From the steam reform stoichiometry equation (Eq. 1), it is observed that water is fed in excess with the H_2O/CH_4 ratio of 4.

Table 3 Number of species (mol) in inlet and outlet streams at methane steam reforming

Species	Inlet	Consumption	Generation	Outlet
CH ₄	1.000	0.900	0.000	0.100
CO	0.054	0.000	0.900	0.954
CO ₂	0.661	0.000	0.000	0.661
N ₂	0.018	0.000	0.000	0.018
H ₂	0.018	0.000	2.700	2.718
O ₂	0.036	0.000	0.000	0.036
H ₂ O	4.000	0.900	0.000	3.100

Table 4 shows the calculated values of each species in the inlet and outlet streams of the WGS reactor.

Table 4. Number of species (mol) in inlet and outlet streams at water-gas shift reactor (step 1)

Species	Inlet	Consumption	Generation	Outlet
CH ₄	0.100	0.000	0.000	0.100
CO	0.954	0.698	0.000	0.256
CO ₂	0.661	0.000	0.698	1.358
N ₂	0.018	0.000	0.000	0.018
H ₂	2.718	0.000	0.698	3.415
O ₂	0.036	0.000	0.000	0.036
H ₂ O	3.100	0.698	0.000	2.403

It can be noticed that the inlet values are the same presented, like outlet values from steam reforming reaction. Also, as expected, after the WGS reaction (outlet stream), the amount of carbon monoxide (CO) was lower, while the hydrogen (H₂) value was higher compared to the inlet stream. Carbon dioxide (CO₂) value was also higher, which can be desirable since such species can be purified and further utilized for urea synthesis. The consumption of H₂O was calculated applying the concept of the extent of reaction (XR) since WGS is a strongly reversible reaction and thus requires the quantification of how far the reaction goes in terms of a fractional consumption of a specified reactant (MORRIS, 2011).

$$XR_{H_2O} = \frac{N_{H_2O}^{in} - N_{H_2O}^{out}}{N_{H_2O}^{in}} \quad (11)$$

Where $N_{H_2O}^{in}$ and $N_{H_2O}^{out}$ are the amount of H₂O in the inlet and outlet streams of steam reforming reactor, respectively.

Thus, the amount of H₂O reacting in the WGS reactor was obtained multiplying XR_{H_2O} (0.23) times the amount available after steam reforming is complete (3.1 mols). A noticeable point concerns the reaction's extent of the reaction being less than one, supporting that the chemical reaction in question is reversible and does not have a limiting reactant. When equilibrium is reached, there is still some reactant present (MORRIS, 2011).

The consumption and generation behavior for each species involved in step 1 can be observed in Fig. 2. It is worth highlighting H₂ and CO₂ curves considerably rising during the process when CO is generated (point 1 to 2, on the x-axis) and later consumed (point 2 to 3, on the x-axis).

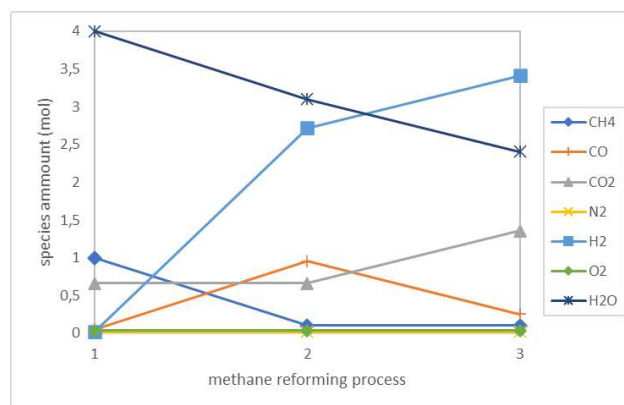


Fig.2: Amount (mol) of each species involved in methane steam reforming was at the x-axis, 1 = reagents input ($N_1 + N_2 = N_3$); 2 = amount (mol) of each species at the steam reforming reactor outlet stream (N_4), and 3 = amount (mol) of each specie at the water-gas shift reactor outlet stream (N_5)

For this theoretical approach, it was considered that all the amount of hydrogen generated in step 1 is fed into step 2, as can be seen in Table 5. From the stoichiometry equation of ammonia synthesis (Eq. 3), the amount of N₂ required is on third of the H₂ amount in the inlet stream. On the consumption column, it is observed that 26% of H₂ conversion (0.888 of 3.417 mols) on the outlet column is considered. It can be observed the amount of NH₃ generated and non-reacted reagents leaving the reactor.

Table 5. Number of species (mol) in inlet and outlet streams at ammonia synthesis reaction

Species	Inlet	Consumption	Generation	Outlet
H ₂	3.415	0.888	0.000	2.527
N ₂	1.138	0.296	0.000	0.842
NH ₃	0.000	0.000	0.592	0.592

It is important to reiterate that at the present work, it has been considered that the amount of ammonia formed is achieved by a single pass through the reactor. Thus, the amount of non-reactant products in the outlet stream is high, corroborating the data about such procedure not being of commercial interest. It must be considered a recycling system for more ammonia, as was firstly proposed by Fritz Haber (PATTABATHULA & RICHARDSON, 2016).

In Fig.3 it is shown the consumption and generation behavior for each species involved in step 2. It can be clearly observed that, as the H₂ conversion is low, the amount of non-reactant products (H₂ and N₂) is higher than the amount of the product of interest (ammonia, NH₃) in the outlet stream (point 2, on the x-axis).

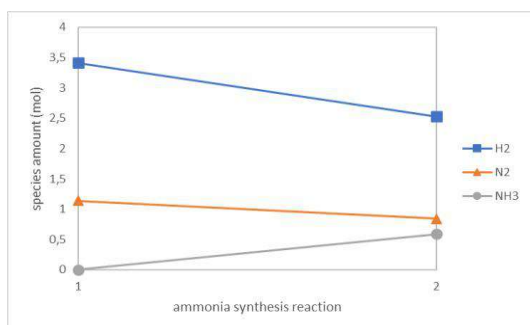


Fig. 3: Amount (mol) of each species involved at ammonia synthesis reaction, where at the x-axis, 1 = reagents input (N6 for H₂ and N7 for N₂); 2 = amount (mol) of each species at the reactor outlet stream (N8).

The synthesized amount of ammonia from step 2 (0.592 mol) is fed into step 3 to react with carbon dioxide and yields urea. The amount value for each species involved in step 3 is shown in Table 6. From the stoichiometry equation of urea obtention (Eq. 4), it is observed that NH₃/CO₂ is two but, as NH₃ is supposed to be fed in excess (ratio of 2.95), the amount of CO₂ in the inlet stream was established to be 0.201 mol (0.592/2.95). Such amount of CO₂ required is lower than the amount produced from step 1, indicating that the surplus amount of CO₂ can be stocked or applied for other purposes. Moreover, the assumed conversion of CO₂ is equal to 60%, justifying the value for CO₂ presented on the

consumption column (0.120 mol). On the outlet column, it is observed that all species are shown in the stream, leaving the process, and the amount of urea produced is equal to the amount of water (0.120 mol).

Table 6. Amount of (mol) in inlet and outlet streams at urea synthesis reaction (step 3)

Species	Inlet	Consumption	Generation	Outlet
NH ₃	0.592	0.240	0.000	0.352
CO ₂	0.201	0.120	0.000	0.080
(NH ₂) ₂ CO	0.000	0.000	0.120	0.120
H ₂ O	0.000	0.000	0.120	0.120

Figure 4 illustrates the consumption and generation behavior for each species involved in step 3. It must be kept in mind that in the present work, for investigating purpose, it was considered that the reaction of conversion of CO₂ and NH₃ into (NH₂)₂CO occurs in the sense of complying with the ideal chemical equation (Eq. 4), not taking into consideration the intermediates and undesirables compounds formation.

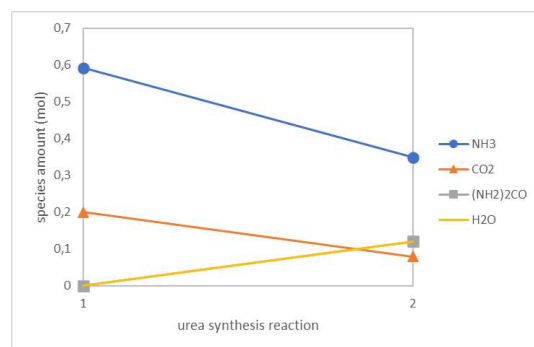


Fig.4: Amount (mol) of each species involved at urea synthesis reaction, where at the x-axis, 1 = reagents input; 2 = amount (mol) of each species at the reactor outlet stream (N11).

To summarize, it was assumed that the process described in the present work was fed with 1.77 moles of biogas (representing 1.00 moles of methane, 56%) and four moles of water vapor. At the end of the process, following the reactions presented and discussed.

It was obtained 0.120 mol of urea, that resulting in a CH₄ / (NH₂)₂CO ratio of 8.31. This proportion can be reduced when considering an industrial process by recycling unused reagents, for example. In relation to the single-pass procedures adopted in the present work, the quantities of species not consumed are:

0.100 mol of CH₄; 0.256 mol of CO; 0.036 mol of O₂; 1.238 mols of CO₂; 2.527 mols of H₂; 0.860 mol of N₂; 0.351 mol of NH₃ and 2,403 mols of H₂O.

It must be emphasized that the time unit of choice can give the basis of calculation regarding inlet material flow (1 mol of CH₄). According to the international system of units, it was assumed that the methane feed flow mentioned above corresponds to one second, which means that all material flows were also considered in terms of one second (mol / s).

Finally, the molecular composition of each stream (following Fig. 1) is shown in Table 7. It is worth noticing the molecular composition is (a) N5 stream, which is the WGS reactor output, presenting high content of H₂ (45.042%); (b) N8 stream, which is the NH₃ synthesis reactor output, presenting higher content of non-reactants (H₂ and N₂) than product (NH₃) and thus evidencing the low conversion rate achieved by a single pass and (c) N11 stream, which is the urea synthesis reactor output, presenting a similar condition to the previously described.

Table 7. Streams molecular composition (%) at each process step

STREAMS					
Specie	N1	N2	N3	N4	N5
CH ₄	56.00	-	1.32	1.32	1.32
CO	3.00	-	12.57	12.57	3.38
CO ₂	37.00	-	8.71	8.71	17.90
N ₂	1.00	-	0.24	0.24	0.24
H ₂	1.00	-	35.83	35.83	45.02
O ₂	2.00	-	0.47	0.47	0.47
H ₂ O	-	100.00	40.87	40.87	31.67
NH ₃	-	-	-	-	-
(NH ₂) ₂ CO	-	-	-	-	-

Specie	N7	N8	N9	N10	N11
CH ₄	-	-	-	-	-
CO	-	-	-	-	-
CO ₂	-	-	-	100.00	11.94
N ₂	100.00	21.26	-	-	-
H ₂	-	63.79	-	-	-
O ₂	-	-	-	-	-
H ₂ O	-	-	-	-	17.91
NH ₃	-	14.94	100.00	-	52.24
(NH ₂) ₂ CO	-	-	-	-	17.91

B. Energy balances

The energy balance analysis was carried out to estimate the amount of heat required to be transferred to or removed from the units presented in Figure 1: heat exchanger (HX), reforming reactor, and WGS reactor, Q1, Q2, and Q3, respectively, on step 1; NH₃ synthesis reactor, Q4, on step 2 and urea synthesis reactor, Q5, on step 3.

For such purpose, the assumptions taken were that ambient temperature, i.e., initial temperature for biogas, was 25 °C, and water flowing into the system was as saturated steam at 100 °C. Moreover, the inlet temperature for the mixture of biogas and water (vapor) for the steam reaction was determined to be 400 °C, seeing that, usually, the reaction mixture before a methane reformer is preheated to 400 to 600 °C (PASHCHENKO, 2019). The reform reactor temperature was established to be 850 °C since it was demonstrated that, at this temperature, methane conversion reaches its maximum (ZHOU et al., 2011). After reforming the reaction, the gaseous mixture is cooled to 340-370 °C before charging in the shift converter (EYALARASAN et al., 2013). Therefore 370 °C was chosen as inlet temperature for the water-gas shift reactor. Also, it was established 630 °C as WGS reaction outlet temperature (EYALARASAN et al., 2013). Dioxide carbon present at WGS reaction product is subsequently absorbed, and the treated gas exits the process at 40 °C (MOLBURG & DOCTOR, 2003).

For the ammonia synthesis, it was considered that H₂ and N₂ inlet temperature is five °C. Moreover, it was established that the ammonia synthesis reactor and the gases are heated to 400 °C. The outlet gas from the ammonia synthesis reactor is cooled at 30 °C, so ammonia is condensed and separated (COPPLESTONE & KIRK, n. d.).

For the urea synthesis, it was considered the inlet CO₂ stream temperature of 40 °C, the same temperature after being recovered at step 1, and the condensate NH₃ stream, from step 2, at 30 °C. In the rector, the temperature reaches 185 °C (MAXWELL, 2004).

Considering that each unit's heat duty can be calculated by considering the total input and output enthalpies of the species, such thermodynamic property was calculated. It was considered the unit of material flow (the basis of calculation) to be of mol/s. Consequently, the unit for calculated enthalpies takes a second (kJ/s). Table 8 presents the enthalpy values considering inlet temperature equal to 25 °C for biogas and 100 °C for H₂O steam and outlet temperature (T) equivalent to 400 °C. It can be

noticed that N_2 , H_2 , and O_2 initial enthalpy values were calculated as zero since, at 25 °C, such elements are in their standard states.

Table 8. Inlet and outlet Enthalpies (H) for species at heat exchanger before methane steam reform (Q1)

Species	Hin (kJ/s)	Hout (kJ/s)
CH ₄	-74.84	-57.61
CO	-5.92	-5.32
CO ₂	-260.00	-249.20
N ₂	0.00	0.20
H ₂	0.00	0.19
O ₂	0.00	0.42
H ₂ O	-956.83	-923.34
TOTAL	-1297.59	1234.65

In Table 9, the calculated enthalpy values of each species in the inlet (T = 400 °C) and outlet (T = 850 °C) streams of the reforming reactor are shown. A significant variation in the values of the species being consumed (CH₄ and H₂O) and generated (H₂ and CO) is observed. It is also noticed the higher value presented by the outlet stream (-950.56 kJ/s) compared to the inlet stream (-1234.65 kJ/s).

Table 9. Inlet and outlet Enthalpies (H) for species at methane steam reformer (Q2)

Species	Hin (kJ/s)	Hout (kJ/s)
CH ₄	-57.61	-4.47
CO	-5.32	-91.51
CO ₂	-249.20	-244.28
N ₂	0.20	0.26
H ₂	0.19	36.68
O ₂	0.42	0.55
H ₂ O	-923.34	-647.78
TOTAL	-1234.65	-950.56

Subsequently, Table 10 presents the values of the calculated enthalpy for each species in the inlet (T = 370 °C) and outlet (T = 630 °C) streams of the WGS converter. It was not illustrated in the process block flow diagram proposed in Figure 1. Nevertheless, it is implied that after leaving the unit of reforming (and before being fed into the WGS converter), the gas stream must be cooled to reach the desired inlet temperature for the WGS reaction. From Table 10, it can be highlighted the variation in the CO₂ enthalpy value, which is formed by the WGS reaction.

Table 10. Inlet and outlet Enthalpies (H) for species at water gas shift converter (Q3)

Species	Hin (kJ/s)	Hout (kJ/s)
CH ₄	-5.93	-5.89
CO	-95.55	-26.20
CO ₂	-250.16	-516.50
N ₂	0.18	0.14
H ₂	27.20	26.29
O ₂	0.38	0.31
H ₂ O	-711.01	-556.40
TOTAL	-1034.88	-1078.25

Table 11 shows the calculated enthalpy values for each species in the input and output currents of the ammonia synthesis reactor. It was considered the purified H₂ from step 1, which was cooled to 5 °C, to be fed into the reactor. The inlet temperature for pure N₂ was also considered at 5 °C, and the temperature of the outlet current was considered to be 400 °C. Thus, the variation in the enthalpy values of inlet and outlet for H₂ and N₂ observed significantly, corroborating to indicate the influence of temperature on enthalpy values. Furthermore, such variation may be mainly related to the temperature change concerning the fact that the variation in the number of moles of H₂ and N₂ in the inlet and outlet currents is slight due to the low conversion of the reagents into ammonia given the single passage in the reactor considered in the present work.

Table 11. Inlet and outlet Enthalpies (H) for species at ammonia synthesis reactor (Q4)

Species	Hin (kJ/s)	Hout (kJ/s)
H ₂	-1.97	28.97
N ₂	-0.66	10.36
NH ₃	0.00	-152.48
TOTAL	-2.63	-113.15

In Table 12, the calculated enthalpy values of each species in the inlet and outlet streams of the reforming reactor are presented. The inlet temperature for CO₂ was 40 °C, which is its temperature after the recovery by ammine purification process following its formation at step 1. On the other hand, the inlet temperature for NH₃ was assumed to be 30 °C, indicating that the produced ammonia from step 2 must be previously cooled before fed into the urea synthesis reactor.

Table 12. Inlet and outlet Enthalpies (H) for species at ammonia synthesis reactor (Q5)

Species	Hin (kJ/s)	Hout (kJ/s)
CO ₂	-78.86	-31.12
NH ₃	-39.68	-21.51
CO(NH ₂) ₂	0.00	-38.41
H ₂ O	0.00	-28.44
TOTAL	-118.53	-119.47

After an estimate of the total enthalpy values of entry and exit for the units, the heat rate can be estimated, and the values are shown in Table 13.

As shown in Table 13, Q1 and Q2 values are positive, indicating that heat must be provided to the unit. Considering that the methane steam reforming reaction is endothermic and, therefore, it demands energy to be carried out, the obtained data is following the expected. A similar consideration can be done regarding Q3, Q4, and Q5 values: as the reactions taking place in the units are exothermic, i. e., release heat, those calculated values are negative, indicating that heat must be removed from the unit. It is essential to point out that the total inlet and outlet stream enthalpies, and therefore the unit heat duty is strongly related to the conversion of the reactants since if this parameter is low, the species enthalpy is accounted for both inlet and outlet streams. Such a situation can be noticed when taking into consideration the Q5 value, for instance: although the urea synthesis reaction presents a well-defined exothermic characteristic, the calculated amount of heat (per second) that must be removed from the unit is minimal (-0.94 kJ) when compared to the other units.

Table 13. Heat duty values calculated for the units of the process block flow diagram to produce urea from biogas

HEAT DUTY	VALUE (kJ/s)
Q1	62.93
Q2	284.10
Q3	-43.36
Q4	-110.51
Q5	-0.94

V. CONCLUSION

A brief process block flow diagram to produce urea from biogas has been demonstrated. Besides, an analysis of material flow (in terms of molecular composition) and energy balance for the proposed diagram

was made. From the material balance, it was possible to present the direction and needed quantity (amount) of reactants and obtained products. Precisely, from 100 kg/s (1.77 mol/s) of biogas, it has been estimated to be obtained approximately 15 kg/s (0.12 mol/s) of urea. The energy balance analysis suggested that input energy is necessary for the heat exchanger unit previously to the methane reforming reactor and for the reforming reactor itself supporting the endothermic character of the reforming reaction. On the other hand, for the remaining units, the heat was shown that heat needs to be removed from the system. Mainly, the purpose of elucidating the potential biogas utilization, which is a nearly endless source, as a feedstock for urea obtention was shown.

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Evaluation of Quality of Life in Individuals at Risk of Obstructive Sleep Apnea and their Anthropometric Correlations

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Life, Sleep Apnea Syndromes, Students.

Abstract— Sleep is a biological condition capable of restoring the body from daily activities, its deprivation can be caused by several disorders, which includes Obstructive Sleep Apnea (OSA). Obesity, among others anthropometric quantities, belongs to the risk factors for OSA. The aim of this study was to evaluate possible relationships between anthropometric factors and the risk of OSA and their correlations with quality of life in students. Analytical observational cross-sectional study carried out with undergraduate university students of both sexes. The characteristics of age, sex, weight and anthropometric measures were used and two questionnaires were applied: STOP-BANG and SAQLI. The sample consisted of 90 participants, of whom 87.8% were considered normal for OSA (Group 1) and 12.2% were at risk of OSA (Group 2). The most influential measures for the Body Mass Index (BMI) were neck circumference (NC) and waist circumference (WC), with associations of +0.311 and +0.580, respectively. The largest problem in the quality of life of the participants was regarding the symptoms of the disease, while the measures that most influenced it were the waist-to-hip ratio (+0.608) and WC (+0.406). Most of the participants had an adequate BMI, while in Group 2, most had a high BMI. The most related problems with quality of life were morning headache, excessive daytime sleepiness and fatigue. It is suggested that BMI and anthropometric measurements increase the likelihood that the individual is at risk for OSA and, consequently, interfere with quality of life.

I. INTRODUCTION

Quality of life is related to the individual's ability to live and feel good. In this context, sleep is essential. Sleep is a biological condition whose main function is the homeostasis of the organism. For this, the organism adapts itself day and night through the sleep-wake cycle, thus determining a biological rhythm. However, when there is sleep deprivation, physical and mental well-being can suffer interference and cause physiological damage. Such

deprivation can be a consequence of sleep disorders, in which Obstructive Sleep Apnea (OSA) stands out. It is a pathological condition still under-diagnosed, but very prevalent in the world ^{1,2}.

Among the manifestations of OSA are excessive daytime sleepiness, tiredness, anxiety, irritability and morning headache. The risk factors for its development involve several mechanisms, from age and sex to chronic diseases. One of the main factors is obesity, especially for

individuals with a Body Mass Index (BMI) larger than 30kg/m^2 , where different anthropometric aspects can contribute to the pathogenesis of this disorder. Anthropometric measurements have been shown to predict the severity of OSA, especially neck circumference (NC), an important predictor for snoring and disposition of fat around the upper airways^{3,4}.

OSA can significantly affect the individual's quality of life, limiting everything from simple day-to-day activities to situations that require greater attention. In addition, when associated with obesity, it is estimated that the individual's limitations are even larger. It can cause reduction in social interactions and emotional functioning, which also trigger academic failure in many higher education students. Apnea carrier's snoring can cause problems with the roommates, it also affects the quality of sleep of those who live in the same household and share the same room, possibly resulting in reduced sexual desire^{3,5,6}.

Considering obesity an important risk factor for the onset of OSA and their influence on the individual's quality of life, the objective of this study was to evaluate the quality of life of university students at risk of OSA and their correlation with anthropometric factors.

II. METHODOLOGY

2.1 Type of study

This is a cross-sectional analytical observational study, based on resolution 466/2012 of the Conselho Nacional de Saúde (National Health Council, Brazil) and approved by the Research Ethics Committee of the Federal University of Alagoas under number 2.825.916.

2.2 Study location

The research has been held at the Federal University of Alagoas - Campus Arapiraca, located in the city of Arapiraca, Alagoas, Brazil. Data collections were performed at the institution's Laboratory of Anatomy.

2.3 Study population

Duly enrolled higher education students from different courses from Federal University of Alagoas took part in the study during research period (from October 2018 to April 2019). The minimal sample estimation (using alpha of 0.01 and standard deviation of 0.05) gave a total of 72 participants. The final total sample was 90 participants of both sexes. However, groups were not expected to have a very different number, due to the lack of predictability in this study to reduce differences between groups.

2.4 Inclusion criteria

The study included students duly enrolled at Federal University of Alagoas, Campus Arapiraca, aged between 18 and 40 years of both sexes.

2.5 Exclusion criteria

Individuals with arterial hypertension, diabetes mellitus, with other metabolic problems and / or using antidepressant pharmacological therapy were excluded, taking into account that the sleep of these individuals may be altered, due to the pathophysiology of their underlying diseases.

2.6 Data collect

Data were collected using an instrument to obtain profile of the participants and anthropometric measurements and two questionnaires to check OSA risk and quality of life.

For the research, the characteristics of age, sex, weight and anthropometric measurements (neck, waist and hip circumference and body height) were used. Two questionnaires were used: STOP-BANG (Snoring, Tiredness, Observed apnea, high blood Pressure, Body mass index, Age, Neck circumference and Gender) and SAQLI (Sleep Apnea Quality of Life Index).

The STOP-BANG questionnaire was developed in Canada, by the University of Toronto and, according to Fonseca et al. (2016), it is used to identify individuals with low and high risk for OSA through 8 objective questions^{7,8}. Thus, this questionnaire was applied to all participants and, based on the evaluation criteria, the individual was classified as: low risk, intermediate risk and high risk for OSA.

As it is considered to be of low risk according to the criteria of the validated questionnaire, the participants who answered up to 2 questions were part of Group 1, above this value, fit in the group of individuals at risk of OSA, Group 2. Therefore, this second group also completed the Sleep Apnea Quality of Life Index (SAQLI) questionnaire, considered by Sampaio et al. (2012) a useful tool to measure the quality of life of patients with OSA⁹.

The SAQLI, which was completed only by participants at risk of OSA, consists of 4 domains, distributed in 40 objective questions. The first domain (A) analyzes the participant's daily functioning, including situations such as the effort to perform the main activities of the day, stay awake and alert while performing such activities, have energy for physical exercises and leisure activities and have good concentration. For domain B, social interactions are addressed, such as snoring disturbing or irritating roommates, not wanting to interact with other people and having inappropriate or infrequent sexual intercourse. In domain C, emotional functioning is analyzed, with an

approach to the feeling of anxiety, frustration, irritability, depression and impatience. In the last domain (D), it addresses the symptoms in the individual, including reduced energy, excessive tiredness, waking up several times during the night, morning headache and non-restorative sleep^{10,11}.

2.7 Data analysis

Based on the evaluation criteria of the SAQLI questionnaire, it was possible to analyze the quality of life of participants at risk for OSA and thus perceive their interference in the daily lives of patients. The questionnaire was distributed to individuals individually, where each read aloud all questions, as they filled out them. To interpret it in the research, the average responses of each domain were classified as: very large problem (1 to 1.9), large (2 to 2.9), moderate to large (3 to 3.9), moderate (4 to 4.9), small to moderate (5 to 5.9), small (6 to 6.9) and no problem (7), reaching an average of the four domains at the end. The higher the SAQLI score, the less the effect of OSA on quality of life¹⁰.

To make the statistical evaluation, tables with variables in percentage values (%) were formulated to describe the profile of the sample. Pearson's Correlation (r) was used for descriptive statistics, assessing the degree of correlation between BMI and anthropometric measures and each of these measures with the four SAQLI domains. The analyzes were classified as very strong (r between 0.9 and 1), strong (r between 0.7 and 0.89), moderate (r between 0.4 and 0.69), weak (r between 0.2 and 0.39) and very weak (0.0 and 0.19), whether positive or negative^{12,13}.

III. RESULTS

The sample consisted of 90 participants (59 women and 31 men) aged between 18 and 34 years. Eleven individuals (12.2%) were at risk for OSA, thus composing Group 2.

Table 1 - Characteristics of the studied sample.

	Frequency	%
Sex		
Male	31	34,4%
Feminine	59	65,6%
BMI		
Under weight	10	11,1%
Adequate	53	58,9%
Overweight and Obesity	27	30%
Group 1	79	87,8%

Group 2

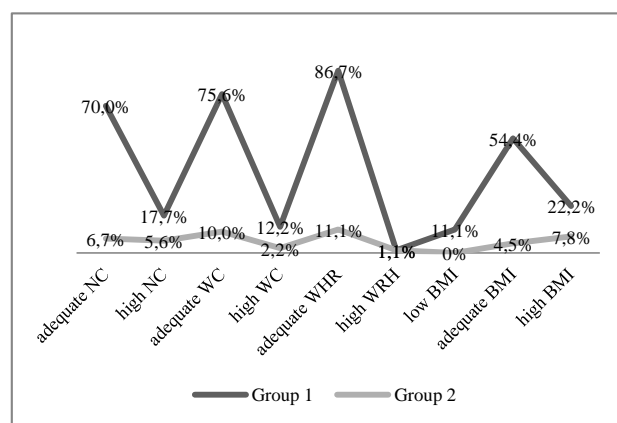
11

12,2%

BMI= Body Mass Index.

According to the World Health Organization (WHO)¹⁴, the appropriate measures for NC, WC and WHR (Waist-to-hip ratio) are, respectively, <37 , ≤ 94 and <1 for males and <34 , ≤ 80 and <0.84 for females. Thus, in this research, both Group 1 and Group 2 were within the parameters according to the general average, as well as group 1 was with adequate BMI (Graph 1), considering the classification of the Associação Brasileira para Estudo da Obesidade e da Síndrome Metabólica (ABESO / Brazilian Association for the Study of Obesity and Metabolic Syndrome)¹⁵, with values between 18.5 and 24.99 kg/m². Although, in the total of participants, the majority had an adequate BMI, in group 2 (12.2%), the majority had a high BMI, inferring that overweight and obesity influence the appearance of OSA.

Graph 1 - Percentage of Individuals in Groups 1 and 2 on NC, WC, WHR and BMI.



NC = Neck Circumference; WC = Waist Circumference; WHR = Waist-to-Hip Ratio; BMI = Body Mass Index.

The application of Pearson's Correlation (Pearson's ρ) was used in order to verify the relationship between BMI and the variables NC, WC and WHR. Among the participants in group 1, there was a moderate positive correlation (+0.604) between BMI and NC and very strong between BMI and WC, analyzing that the higher the BMI, the greater the NC and WC.

When analyzing WHR, BMI had a weak positive correlation (+0.331). As in group 1, the main correlation in group 2 was between BMI and WC (+0.580), which was moderately positive. NC and WHR had a weak positive correlation (+0.311) and very weak (+0.079), respectively, with the BMI in this same group. Between the two groups, none of the anthropometric measurements showed a negative correlation with BMI (Table 2).

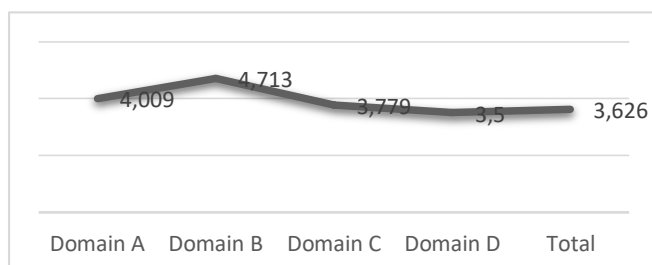
Table 2: Correlation between BMI and anthropometric measurements.

Variables	r (Group 1)	r (Group 2)
BMI e NC	+0,604	+0,311
BMI e WC	+0,902	+0,580
BMI e WHR	+0,331	+0,079

r = Pearson's correlation; BMI = Body Mass Index; NC = Neck Circumference; WC = Waist Circumference; WHR = Waist-to-Hip Ratio

According to the score of the domains of the quality of life questionnaire (SAQLI), none of the domains presented an average so that there was a major problem with the quality of life of the participants in group 2 (Graph 2). In general, the influence of OSA on quality of life is moderate to large (3,626). When analyzing the four domains, the one that has the greatest impact for the participants is the D (3,5) presenting a moderate to large problem in the symptoms of the disease, followed by the C domain (3,779), interfering in the participant's emotional functioning. As for the other two domains, A and B, which represent daily functioning and social interaction, respectively, OSA presented a moderate problem.

Graph 2 - Average Score of the SAQLI Questionnaire Domains.



SAQLI = Sleep Apnea Quality of Life Index

Also using Pearson's ρ , the relationship between the variables NC, WC, WHR and BMI with the 4 SAQLI domains was analyzed. The data presented in Table 3 show that for domain A, referring to daily functioning, the one that most influences quality of life is WHR, with a strong positive correlation (+0.783), followed by NC and BMI, presenting, respectively, weak negative and positive correlation. Thus, the greater the WHR, the greater its interference in domain A, the same happening for BMI. For domain B, only WHR showed a positive correlation, although very weak (+0.062), while BMI represented a weak negative correlation (-0.320). In domain C, all variables showed a weak or very weak correlation,

whereas in domain D, only NC presented this way (-0.024). The greatest influence for this latter domain, as well as in A, is that of WHR, thus being a moderate positive correlation assessing that the higher the WHR, the greater its influence on the symptoms of the disease, including morning headache, excessive fatigue and non-sleeping repairman.

Table 3: Correlations of SAQLI domains with NC, WC, WHR and BMI

Variables	Domain A	Domain B	Domain C	Domain D
NC, cm	-0,309	-0,074	-0,266	-0,024
WC, cm	+0,035	-0,080	+0,250	+0,406
WHR	+0,783	+0,062	+0,164	+0,608
BMI	+0,382	-0,320	-0,228	-0,411

NC = Neck Circumference; WC = Waist Circumference; WHR = Waist-to-Hip Ratio; BMI = Body Mass Index.

IV. DISCUSSION

In the present research, the influence of obesity on OSA risk was identified, as well as the correlation between this sleep disorder and the quality of life in these undergraduate students. Some of our results shown discrepancies with previous studies on higher education student populations on different countries. Our study suggests that the increase in body mass index explains the frequency of OSA and that the presence of this sleep disorder affects the quality of life¹⁶⁻¹⁸. To our best knowledge, this is the first study of this correlation on a Northeast Brazilian population.

An original study by Saygin et al. (2016)¹⁶ with 337 university medical students from Turkey identified that only 5 (1.5%) were diagnosed with higher OSA risk. According to Khassawneh et al. (2018)¹⁷ this percentage reached 5.4% on higher education students from Jordan, whereas it was found by Carvalho et al. (2015)¹⁹ that this percentage reached 23,13% on Sirian-Lebanese Hospital from southeast Brazil, in our study OSA risk was 12.2% on the population studied.

On the other hand, Wosu et al. (2014)²⁰ have identified that 7,8% of Chilean college students had higher OSA risk, and these, 12,8% had general obesity and 42,7% had central obesity. The evidence on the relationship between obesity and OSA suggests that the increase in fat mass restricts the normal flow of air, in addition to the fact that this increase is capable of reducing residual capacity and tidal volume of air, changing pulmonary mechanics.

However, the presence of this disorder is not restricted to the physical size of individuals²¹. Although the complete mechanisms involved in the association of OSA and WC are not clear, disposition of fat around the upper airway is one of the explanations for its collapse during sleep^{20,22-24}. Our results have demonstrated, as in other studies²⁵⁻²⁷, that NC and WC have strong correlations with BMI.

Researches carried out with university students on Chile²⁰ and on Thailand²⁸ have found a *strong positive correlation* between WHR and BMI. This is in contrast with our findings, which identified a *weak positive correlation* (+0,331). When one analyzes all the anthropometric measures evaluated, those that most influenced the increase in BMI, *i.e.*, obesity, were NC and WC. Therefore, the higher these measures, the higher the individual's BMI and, consequently, increased physical and mental damage¹⁸. A study conducted with apnea patients in 2016 by Coman *et al.*¹⁰ concluded that NC and BMI have little significance with the severity of quality of life, this is in agreement with the findings in our study. Whereas, for Dutt et al. (2013)²⁹, the SAQLI domain D, representative of symptoms, including BMI, had greater influence on this quality of life issue.

In our current study, the SAQLI four-domain analysis showed that the one most affected by anthropometric measurements and BMI is domain A, mostly influenced by WHR and BMI. Therefore, it is possible to infer that the higher WHR and BMI, the higher influence of OSA over the most important daily activities, such as staying awake while performing the main activities of the day or relaxing, or in general activities such as concentrating or having good memory. A study with medical students from Colombia, Barahona-Correa in 2018 identified that sleep problems are often reported and this condition can trigger psychological disorders and learning difficulties³⁰.

For Pacheco and dos Anjos³¹, such losses are often observed, especially changes in mood, irritability, and lack of concentration and memory. The consolidation of memory and learning is totally influenced by the reactivation of mnestic traces during sleep, when the brain is protected from the interference of external stimuli, especially in the REM (Rapid Eye Movement) phase¹.

Thus, the losses resulting from poor sleep quality in students with OSA affect their daily activities, and may interfere with their academic learning, as perceived in our present study, although there was no statistically significant difference between the domains or in the global average of the questionnaire quality of life (SAQLI).

The most reported issues were those belonging to the SAQLI 4th domain, representing the symptoms associated

with OSA, as morning headache, excessive daytime sleepiness, and fatigue. As such, this has shown that the larger the severity of OSA, the more expressive its perceived symptoms. The association between these symptoms and sleep can be explained by the change in the release of serotonin and melatonin and the increase in REM sleep, in addition, morning headaches are strongly influenced by the decrease in hours of sleep and high amount of nighttime awakenings³².

In our study, most participants have adequate WHR, according to what was proposed by the WHO. As presented on the literature³³, WHR is the one factor that has largest influence on daily activities degradation from the OSA-risk population, as it interferes in waking state, concentration, and symptoms appearance. This can be explained by the fact that WHR is one of the main indicators of central obesity, given the excess distribution of adipose tissue in overweight individuals.

In groups of military veterans with health-related low quality of life and presence of OSA, Vinnikov *et al.*³⁴ have identified the presence of increased fatigue. In addition, Vinnikov *et al.* realized that sleepiness and fatigue were important determinants for reducing the quality of life, consequently affecting sleep quality. Such result is in agreement with our findings on this report. It is also essential to understand that the effect of sleep disorders and excessive daytime sleepiness is influenced by external factors, such as culture, social, and economic environment. Thus, it is necessary to understand these external factors in order to correctly intervene in these points to improve general population health, since OSA is a public health problem^{30,34}.

In individuals with OSA-reduced quality of life, the functional capacity to perform daily activities can be compromised, especially when OSA is not treated. Other physiological impairments caused by poor sleep quality can be involved in the apnea process, as some pulmonary and cardiovascular disorders resulting from limitation of inspiratory flow and reduction in expiratory volume⁷. Strong OSA limitations and effects on the quality of life can origin further physical, physiological and psychological problems to these individuals.

V. CONCLUSION

This study has made it possible to analyze the presence of OSA risk among students from different courses of a Brazilian Northeast university, as well as the influence of BMI and anthropometric measures for their development.

In addition, it was possible to analyze the quality of life of students at risk for OSA (Group 2).

We have found that OSA, obesity and quality of life are interconnected. Thus, our results suggest that BMI and anthropometric (neck, waist and hip circumference and body height) measures can increase the likelihood of OSA incidence risk and, in consequence, interfere in the quality of life. This reflects on the answers obtained on questions related to daily activities. From mild symptoms like lack of energy, difficulties to perform physical exercises or to remain awake, social interaction problems (e.g., annoying snoring and frequent conflicts), and emotional functioning (e.g., impatience, frustration, and fear) to more severe OSA symptoms, fatigue, lapses of attention, and morning headache.

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Mathematical modeling and parametric optimization of surface roughness for evaluating the effects of fused deposition modeling process parameters on ABS material

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Keywords— ANOVA, FDM, Parameter optimization, RSM, Surface roughness, Taguchi method.

Abstract— Fused deposition modeling (FDM) technology is production devices that use plastic material in the semi-molten state to harvest the products directly from the CAD model. This study describes the development of mathematical models to predict the effects of significant process parameters of the FDM on the surface roughness of ABS material. Experiments were planned as per Taguchi L_9 orthogonal array. Experiments were conducted under different printing input parameters of layer thickness, orientation angle, and infill angle. Response surface methods (RSM) have been employed to develop a predictive mathematical model in terms of controllable input parameters. Analysis of Variance (ANOVA), main effect and interaction plot, 3D surface, and contour plot were used to investigate the influence of various printing parameters on surface roughness. Finally, Taguchi methodology and RSM approaches have been applied successfully for the optimization of surface roughness (R_a) in FDM printing parts. It was observed that the models can adequately describe the responses within the ranges considered as the maximum error percent in the prediction of mean R_a and S/N ratio of R_a are 14.61% and 18.83% respectively, which is in good agreement. The optimal combination of printing process parameters obtained indicates that optimum surface quality is layer thickness at 0.1mm, orientation angle at 0°, and infill angle at 0°.

I. INTRODUCTION

Additive manufacturing (AM) is a technology that uses digital three-dimensional model data to manufacture physical objects. In the AM process components are built gradually layer by layer. Nevertheless, in the traditional manufacturing process material have to machine to fabricate parts. Additive manufacturing processes use multiple 3D printing methods, but the most used is the process known as Fused Deposition Modeling (FDM) [1]–[4].

FDM printers use thermoplastic filaments that are heated to melting point and then through extrusion nozzle layer by layer to create 3D objects according to CAD design. The system is made up of a control system, a production platform, and an extrusion nozzle. FDM can create conceptual models, production parts, and working prototypes with exceptional thermal and chemical resistance and excellent strength-to-weight ratios. FDM uses technical grade solid materials such as ABS, polycarbonate, and ULTEM™ 9085 resin [5]–[7].

FDM technology offers considerable advantages such as simpler and easy demodulation frequency, not need synchronization between its transmitter and receiver, the slow narrowband fading only one channel gets affected, It is used for analog signals, and simultaneously many signals can be transmitted [8]–[12].

When setting the printing options of the machine, several process parameters have to be taken into account, such as temperature, build speed, infill densities, etc., which directly influence the quality (surface roughness) of the fabricated parts. Selecting these parameters also a great challenge for the users and is generally solved by experience without considering their influence on the product[13]–[18].

Several authors have experimentally studied the problems related to the surface roughness of plastic parts produced by FDM and developed theoretical and empirical models. P. Wang et al.[19] studied the effects of the printing parameters of molten deposit modeling on the mechanical properties, surface quality, and microstructure of polyetheretherketone (PEEK). The FDM method was applied to obtain the 3D printing of PEEK. Finite Element Analysis (FEA) was used to simulate the melting conditions and fluidity of PEEK in a flow channel, to determine the parameters necessary to print PEEK parts in 3D with sufficient surface quality and improved mechanical properties.

P. Wang et al.[20] Studied influence of FDM printing parameters such as; nozzle temperature, printing speed, layer thickness, deposition road width as well temperature of printing platform on the surface morphology of printed parts. The experiments were performed on FDM 3D printing several times and the surface roughness result was used to develop a predictive model. The experimental results were in good agreement with the predicted model.

D. Yadav et al.[21] Studied the influence of 3D printing parameters such as material density, infill density, and extrusion temperature on tensile strength of printed parts using FDM. Acrylonitrile Butadiene Styrene (ABS), Polyethylene Terephthalate Glycol (PETG), and Multi-material were used for printing materials. 30 parts were printed having different parameters as per the ASTM D638-(IV) standard. For training and optimization, purpose the artificial neural network (ANN) and genetic algorithm-artificial neural network (GA-ANN) hybrid tool were used. It was observed that the tensile strength is improved by 4.54% and it has been proved experimentally.

C. Abeykoon et al. [22] Examined three FDM parameters like infill pattern, infill density, and infill speed, at two variable settings for building test parts on the properties of FDM 3D, printed specimens (i.e., mechanical, thermal,

and morphological). Comprehensive analyses were performed to test printing parts and the result showed increasing infill density will increase the strength of the printed parts.

V. Wankhede et al. [23] Studied the effect of 3D FDM process parameters on printed part quality by using Acrylonitrile Butadiene Styrene (ABS) polymer material. Inputs factors are infill density, layer thickness, and support style, and the output factors were Surface roughness and build time of part. Analysis of Variance (ANOVA) is established to understand the significant characteristics of the process variables. The set of input variables has been determined for the individual output response variable. From the study of research papers on FDM, it is found that different process parameters for improving quality of printed part like, DA, Ra, and UTS, etc., different optimization techniques were used in single or hybrid with other technique. Since this technology is resented insufficient work has been done for modeling and optimization of flash forge creator process parameters for certain materials.

II. EXPERIMENTAL DETAIL

2.1 Experimentation setup: Selection of parameter

Printing parameters have a dominating impact on the quality of build part characteristics and their production efficiencies. To ensure the quality of printed parts, it is necessary to study the influence of inputs printed parameters and out factors. In this paper, layer thickness (mm), orientation angle (°), and infill angle (°) were considered as controllable input parameters. Table 1 shows three input variables of the experiment, coded value, and actual values of their level.

Table.1: Controllable input parameters and their levels

Input parameters	Symbol	Unit	Levels		
			1	2	3
Layer thickness	A	mm	0.1	0.2	0.3
Orientation angle	B	°	0	15	30
Infill angle	C	°	0	30	30

2.2 Design of experiment

The design of the experiment using Taguchi's provides an efficient plan to study the experiments, with a minimum amount of experimentation. Based on selected process parameters and their levels an experimental design matrix was constructed (Table 2) using Taguchi L9 orthogonal array (three levels-three factors) were selected depends on

the number of input parameters and their levels. Each experimental trial in the design consists of different FDM printing parameters with different levels.

Table.2: L_9 orthogonal array design of experiments (DOE)

EXP. Trials	Input parameters		
	A	B	C
	mm	°	°
1	0.1	0	0
2	0.1	15	30
3	0.1	30	60
4	0.2	0	30
5	0.2	15	60
6	0.2	30	0
7	0.3	0	60
8	0.3	15	0
9	0.3	30	30

2.3 Specimen fabrication

The 3D models of specimens are generated using SOLID WORK 2016 solid modeling software and exported as STL (stereolithography) file to FDM software (Insight). Figure 1 is showing the specimen model on solid work. The specimen was placed flat on the building plate virtually in the slicing software. X, Y, and Z-axis directions are shown. After this process, the data is sent to the FDM hardware for modeling. Figure 2 shows the FDM machine while printing parts. Figure 3 shows parts fabricated by using FDM.

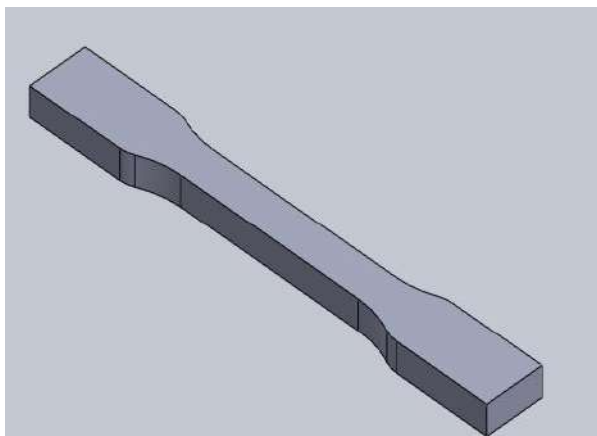


Fig. 1: Specimen model on Solid work



Fig. 2: FDM machine



Fig.3: Parts fabricated by FDM machine

2.3 Experimentation setup: Selection of parameter

The surface roughness of each fabricated part was measured at five different places on the top and bottom surfaces and the average values used for analysis, the unit of measure is μm . The laser scanning microscopy (VK- X 200 K, Keyence, Japan) equipment is used to measure the surface roughness of the fabricated part. Table 3 shows the experimental data set and experimental results.

Table.3: Experimental layout and results

Exp. Trials	A	B	C	Experimental results	
				Ra	S/N ratio
				(μm)	
1	0.1	0	0	0.3265	9.72234
2	0.1	15	30	0.5925	4.54623
3	0.1	30	60	0.5988	4.45436
4	0.2	0	30	1.0545	-0.46093
5	0.2	15	60	1.2165	-1.70224
6	0.2	30	0	1.2095	-1.65212
7	0.3	0	60	1.3375	-2.52588

8	0.3	15	0	1.3425	-2.55829
9	0.3	30	30	1.6542	-4.37176

III. RESULT AND DISCUSSION

3.1 Surface roughness (Ra) analysis

Analysis of variance (ANOVA) was used for analyzing experimental results of surface roughness to identify the significant factors affecting the performance measures. In table 4 result of the ANOVA for the mean surface roughness at a 95% confidence interval is given. For significance check, F – value, and P-value are given in the ANOVA table are used. The principle of the F-test and P-test is that the larger the F value and a smaller value for a particular parameter, the greater the effect on the performance characteristic due to the change in that process parameter. ANOVA table shows that layer thickness (F – value 193.88), Infill rate (F – value 4.28) has the most significant factor that affects the Ra and has an insignificant effect on Ra respectively. Table 5 shows the ranks of various factors in terms of their relative significance.

Table 4: ANOVA table for Surface roughness

Source	DF	Adj SS	Adj MS	F-Value	P-Value
A	2	1.39034	0.695172	193.88	0.005
B	2	0.09308	0.046541	12.98	0.072
C	2	0.03066	0.015330	4.28	0.190
Error	2	0.00717	0.003586		
Total	8	1.52126			

Table 5: Response Table for Means surface roughness

Level	A	B	C
1	0.5059	0.9062	0.9595
2	1.1602	1.0505	1.1004
3	1.4447	1.1542	1.0509
Delta	0.9388	0.2480	0.1409
Rank	1	2	3

The main effects plot for the Ra is shown in Figure 4, which shows the variation of surface roughness with the input parameters. The interaction plot for the Ra is shown in Figure 5, which shows the interaction between process parameters on the surface roughness. From the main effect plot for mean surface roughness, it is indicated that the orientation angle and infill angle have less influence on surface roughness. The percentage contribution pie chart

plot for the Ra is shown in figure 6, which shows the influence of each process parameters in percentage. The percentage contribution of layer thickness is 91.827 %, the contribution of the orientation angle is 6.148 % and the contribution of infill angle is 2.025 %. This shows that layer thickness has a significant contribution to surface roughness followed by orientation angle.

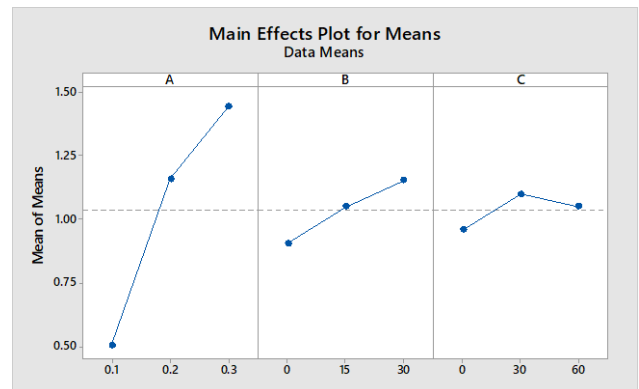


Fig. 4: Main effects plot for means Ra with all process parameters

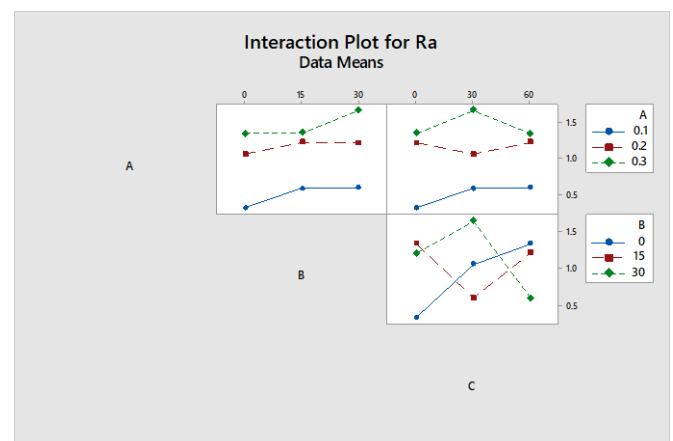


Fig. 5: Interaction plot of Ra for means with all process parameters

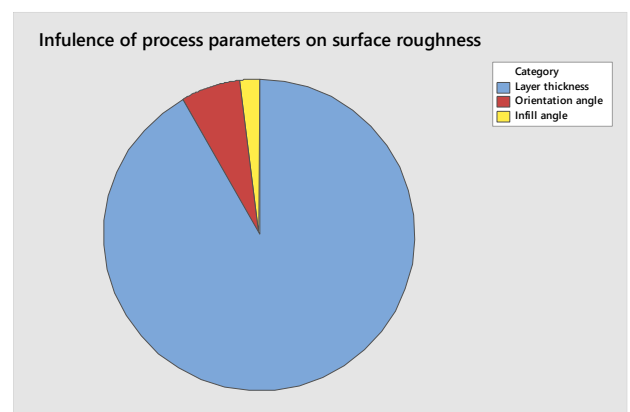


Fig. 6: Pie chart for percentage contributions

3.2 Response surface method (RSM) modeling

3.2.1 Regression analysis

The experimental data obtained from the L₉ orthogonal array was analyzed for surface roughness using regression analysis. The analysis was done using coded units. Once the Ra values were entered into Minitab V18 (trial version 18.1), a whole analysis can be performed using regression analysis. The results shown in Table 7 are the estimated regression coefficients for surface roughness to all the terms in the model.

Table 6: Estimated regression coefficient for mean surface roughness

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	-0.688	0.209	-3.30	0.030	
A	12.09	2.31	5.23	0.006	49.00
B	0.00827	0.00220	3.76	0.020	1.00
C	0.00152	0.00110	1.39	0.238	1.00
A*A	-18.48	5.71	-3.23	0.032	49.00

Applying the ANOVA on the experimental data, we obtained the influence of each parameter and the adequacy of the data. Table 7 shows ANOVA for Ra and a summary of the model. Values of "Prob > F" less than 0.0500 (i.e., $\alpha = 0.05$, or 95% confidence level) indicate model terms are significant. P - Values greater than 0.1000 indicate the model terms are not significant, which implies the Lack of Fit is significant, this large could occur due to noise. R-sq. shows the agreement between actual and fitted value, in this case, R-sq. is given as 98.28%, which showed that the model is fit.

Table 7: ANOVA for surface roughness

Source	D F	Adj SS	Adj MS	F-Value	P-Value
Regression	4	1.4951	0.37378	57.25	0.001
Error	4	0.0061	0.00152		
Total	8	1.5012			
Corrected Total	7	1.4890			
Model	4	1.4951	0.37378	57.25	0.001
Residual	3	0.0061	0.00203		
Adjusted R-sq				98.28%	
Predicted R-sq				96.57%	
Adjusted R-sq (pred)				91.47%	

Total	8	1.5212	
	6		
Model Summary			
S	R-sq	R-sq(adj)	R-sq(pred)
0.0808051	98.28%	96.57%	91.47%

Based on the developed surface roughness regression equation, 3D surface and contour graphs are plotted for surface roughness against layer thickness, orientation angle, and infill angle. Figure 7 (a-b) shows a 3D surface and contour plot of the interaction analysis between layer thickness and orientation angle. The infill angle for this analysis was set at a constant 30 degrees. From this plot, it is clearly shown that the lower surface roughness is obtained at a layer thickness between 0.10 mm to 0.15 mm, and the orientation angle between 0 to 5 degrees. We can be also observed that the surface roughness was high at higher layer thickness and orientation angle.

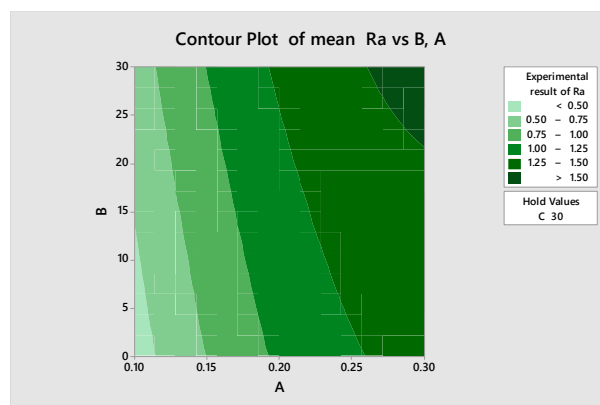


Fig. 7(a): Contour plots of Ra against layer thickness and orientation angle

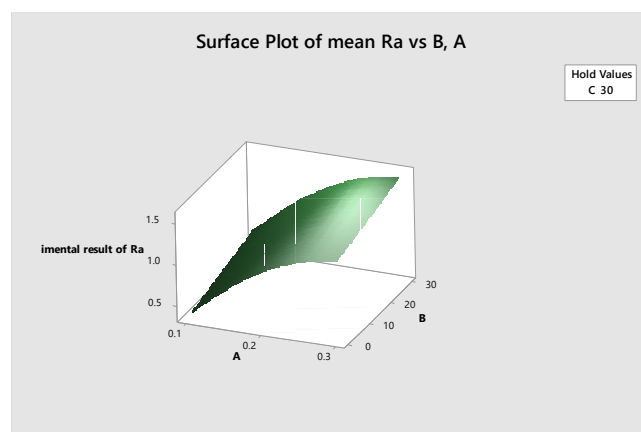


Fig. 7(b): 3D Surface plots of Ra against layer thickness and orientation angle

Figure 8(a-b) shows a 3D surface and contour plot of the interaction analysis between layer thickness and infill angle. The orientation angle for this analysis was set at a constant 15 degrees. From this plot, it is shown that the lower surface roughness is obtained at a layer thickness between 0.10 mm to 0.15 mm, and the orientation angle between 0 to 30 degrees. We can be also observed that the infill angle has an insignificant effect on kerf width.

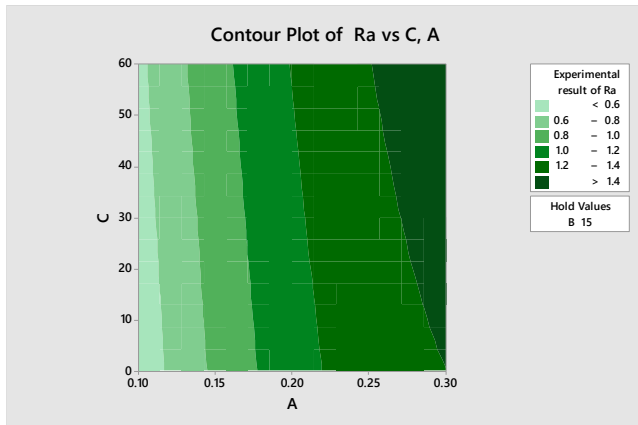


Fig. 8(a): Contour plots of Ra against layer thickness and infill angle

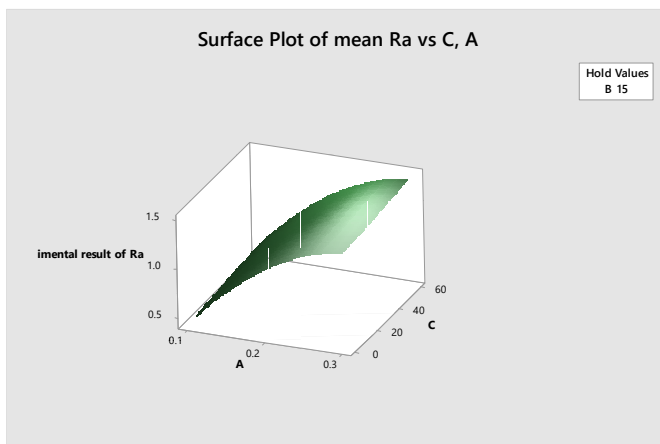


Fig. 8(b): 3D Surface plots of Ra against layer thickness and infill angle

Figure 9(a-b) shows the 3D surface and contour plot of the interaction analysis between orientation angle and infill angle. The layer thickness for this analysis was set at a constant of 0.2 mm. From this plot, it is shown that the lower surface roughness is obtained at an orientation angle between 0 to 5 degrees, and an infill angle between 0 to 10 degrees. At high orientation angle and infill angle, the surface roughness was higher.

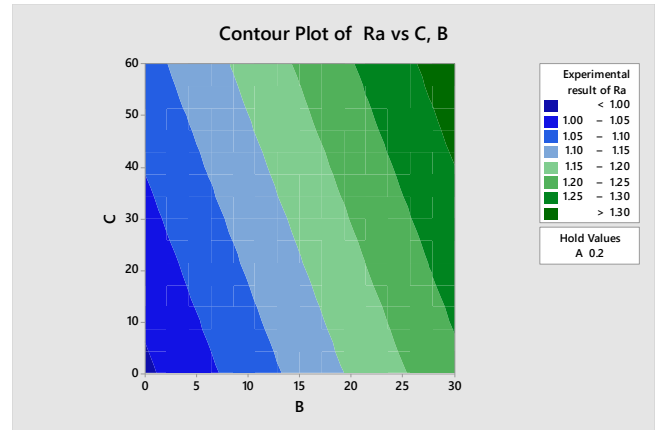


Fig. 9(a): Contour plots of Ra against orientation angle and infill angle

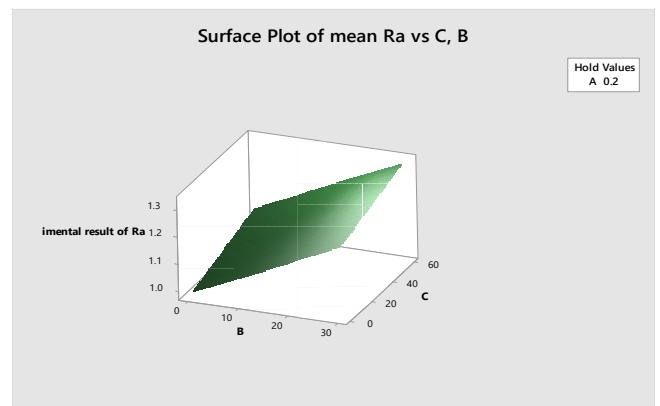


Fig.9(b): 3D Surface plots of Ra against orientation angle and infill angle

3.2.2 Mathematical modeling: mean surface roughness and S/N ratio

The mathematical models for the printed part using Fused deposition modeling (FDM) were developed to evaluate the relationship between process parameters to the fabricated part quality. To model the experimental data, response surface models were used with the help of Minitab statistical software. Through these models, experimental results of Ra by any combination of printing parameters can be estimated. The output response and the input printing parameters are related through the mathematical model given in Equations (2) and (3).

Equation – 2

$$Ra = 0.688 + 12.09 A + 0.00827 B + 0.00152 C - 18.48 A * A$$

Equation – 3

$$\frac{S}{N} \text{ ratio} = 21.81 + 160.3 A + 0.0947 B + 0.0302 C - 282.7 A * A$$

The mathematical model developed in Equations (2) and (3) above was used for the prediction of Ra and the S/N

ratio of Ra. Table 9 summarizes the predicted result of the mean and S/N ratio of Ra. The time series plot for the Ra is shown in Figures 10(a) and (b), shows the comparison between the experimental results and predicted results for the mean and S/N ratio of Ra. It can be realized from the results that the predicted values are close to experimental values. Therefore, the developed regression equation can be used as the objective function for the optimization.

Table 8: Experimental results and predicted result for surface roughness

Ex p. tri als	A	B	C	Experimental results		predicted results	
				Ra (μm)	S/N ratio	Ra (μm)	S/N ratio
1	0.1	0	0	0.326 5	9.72234	0.3362 2	8.50610
2	0.1	15	30	0.592 5	4.54623	0.5059 3	6.24098
3	0.1	30	60	0.598 8	4.45436	0.6756 5	3.97585
4	0.2	0	30	1.054 5	- 0.46093	1.0361 7	0.11241
5	0.2	15	60	1.216 5	- 1.70224	1.2058 8	-2.15271
6	0.2	30	0	1.209 5	- 1.65212	1.2384 5	-1.77499
7	0.3	0	60	1.337 5	- 2.52588	1.3664 5	-2.64875
8	0.3	15	0	1.342 5	- 2.55829	1.3990 2	-2.27103
9	0.3	30	30	1.654 2	- 4.37176	1.5687 3	-4.53615

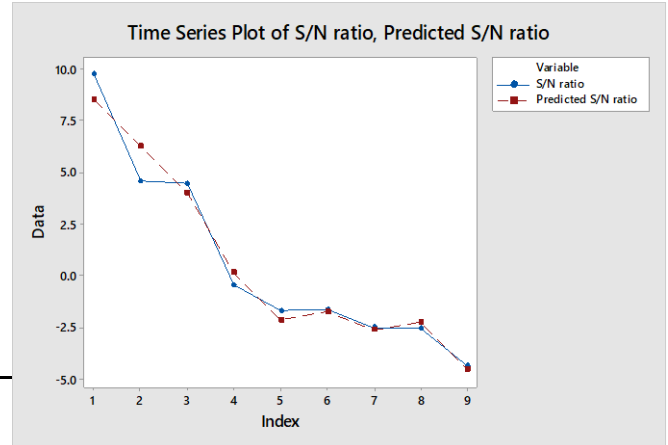


Fig. 10(b): A time series plot: experimental result and predicted result for S/N ratio

3.2.3 validation of the model

Validation of the mathematical models with the experimental results is shown in Figures 10 (a) and (b). The percentage of prediction error is calculated as:

Equation 4

$$\text{Prediction error \%} = \frac{\text{Experimental result} - \text{predicted result}}{\text{Experimental result}} \times 100$$

It is observed that the models can sufficiently describe the responses within the ranges considered as the maximum error percent in the prediction of mean and S/N ratio of Ra are 14.61% and 18.83% respectively, which is in good agreement. This indicates that the average percentage accuracy in the mean and S/N ratio of Ra values is 85.39 % and 81.17 % respectively.

3.3 Multi-objective optimization

3.3.1 Taguchi method optimization

Optimization using Taguchi methods have three conditions; smaller is better, nominal is better, and large is better. In this condition of the printed part using FDM, the smaller the surface roughness is the optimal condition. Process parameters settings with the highest S/N ratio always yield the optimum quality with minimum variance. Based on the S/N analysis, the optimal printing parameters for Ra are at layer thickness 0.1mm, the orientation angle of 0 degrees, and 0 degrees infill angle.

3.3.2 RSM optimization

From the optimization plot Figure 11, it is observed that mean surface roughness and S/N ratio shows individual desirability as 0.99268 and 0.91371 respectively. The optimum response values of mean Ra and S/N ratio obtained are 0.3362 μm and 8.5061 respectively. Tables 8 summarize optimum values using Taguchi methodology and predicted optimum values using the RSM approach for mean Ra and S/N ratio Ra.

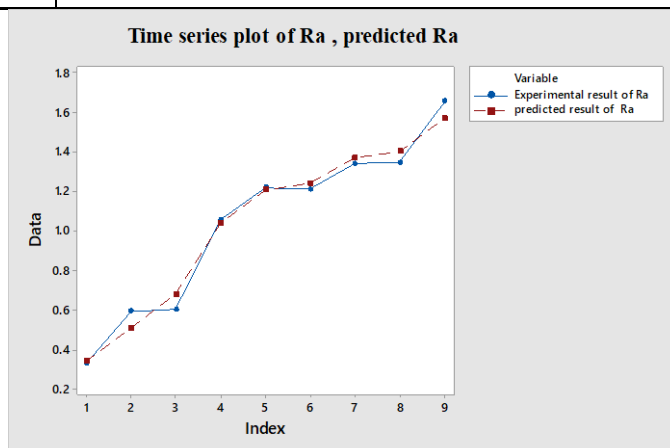


Fig. 10(a): A time series plot: experimental result and predicted result for mean Ra

Table 9: Optimum value using Taguchi methods and RSM approaches

	Response		Factors		
	Mean Ra	S/N ratio	Layer thickness	Orientation Angle	Infill angle
Optimized Value using Taguchi methodology	0.3265 μ m	9.7223	0.1 mm	0°	0°
Predicted optimum value using RSM	0.3362 μ m	8.5061	0.1 mm	0°	0°

drawn:

- The ANOVA result shows that surface roughness (Ra) has most significantly affected by layer thickness. On the other hand, Ra is found to be insignificantly affected by orientation angle and infill angle.
- The percentage contribution of layer thickness is 91.827 %, orientation angle is 6.148 % and infill angle is 2.025 %. This shows that layer thickness has a significant contribution to surface roughness followed by orientation angle.
- The lower surface roughness is obtained at a layer thickness between 0.10 mm to 0.15 mm, the orientation angle between 0 to 5 degrees, and infill angle between 0 to 10 degrees. At high layer thickness, orientation angle, and infill angle, the surface roughness was higher.
- The models can adequately describe the responses within the ranges considered as the maximum error percent in the prediction of mean Ra and S/N ratio of Ra are 14.61% and 18.83% respectively, which is in good agreement.
- The optimum mean Ra value through the Taguchi method is $Ra = 0.3265 \mu\text{m}$ at a maximum value of S/N ratio 9.72234.
- The optimum response values of mean Ra and S/N ratio obtained using the RSM approach are $0.3362 \mu\text{m}$ and 8.5061 respectively. It was observed that surface roughness and S/N ratio show individual desirability as 0.99268 and 0.91371 respectively.
- The optimal combination of printing process parameters obtained from the Taguchi method and RSM optimization indicates that optimum surface quality is layer thickness at 0.1mm, orientation angle at 0°, and infill angle at 0°.

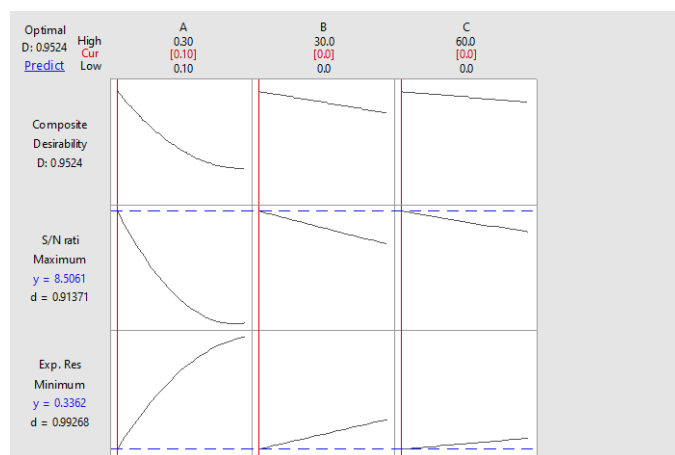


Fig. 11: Optimization of response parameters using RSM

IV. CONCLUSION

In the present work, Fused deposition modeling (FDM) has been used to print ABS parts. The experiment has been carried out using Taguchi's L_9 orthogonal array technique to relate printing parameters such as layer thickness, orientation angle, and infill angle to surface quality responses in terms of surface roughness. The surface roughness of each fabricated part was measured at five different places on the top and bottom surfaces and the average values used for analysis. To analyze the effect of each process parameters on response analysis of variance (ANOVA), main effect and interaction plot, 3D surface, and contour plot has been used. A mathematical model is developed using RSM through regression analysis for further prediction. Finally, Taguchi methodology and RSM approaches have been applied successfully for the optimization of surface roughness (Ra) in FDM printing parts.

From the result obtained, the following conclusions are

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Selection and Customization of Product Assurance Requirements applied to Small Satellites

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Keywords— Small satellite, Reliability,
Selection of requirements, Product
assurance.

Abstract— The use of small satellites has become a technological trend in the aerospace sector. To guarantee the specified reliability, every space mission requires adequate product assurance requirements, so that the risks and costs of the program are at predefined levels. This article proposes a process for selecting and customizing product assurance requirements applied to small satellites, aiming gains in manufacturing time, scope or cost, without increasing the risk of project execution. The proposed process cannot affect the objective of the mission, ensuring that all requirements successfully established are met. For this, a combination of two methods is proposed: AHP-Sort and the Borda method. The AHP-Sort is a variation of the Analytic Hierarchy Process, known as AHP methodology. Its use is indicated for classification and reduction of alternatives. In this work, specifications defined by the stakeholders are used, such as risk, lifetime and type of mission, which will be analyzed under the degree of importance, pair to pair, which will allow the classification of satellites in A, B, C or D. Once those classes are defined, the requirements referring to the different disciplines of the product assurance are allocated to each class, compatible with the risk margin accepted for the mission. To complete the selection and customization of product assurance requirements, the Borda method will be used for ordering and ranking the requirements of each product assurance discipline by specialists who will make an assessment, establishing notes for each requirement, which, after being compiled, will indicate the one's that must be applied to each class of satellite.

I. INTRODUCTION

1.1. Context

In the space area, the products are complex and require high reliability during the mission, therefore, it is extremely important that the organization maintains a rigorous process of selecting requirements for ensuring the quality of the product. The set of requirements derived from this reference will be used as a basis for the development of a specific product assurance plan for each project. Regardless of size, space system projects have the

required quality according to their criticality, assessed through technical and managerial interests.

The complexity of managing a rigorous requirements selection process for space products makes this process expensive and time-consuming. To reduce the cost and / or time of manufacturing of the small satellites it is necessary to use a process of selection and customization of product assurance requirements, to define and accommodate the unique aspects of each program or project, in order to achieve the success of the mission in an efficient and economical way.

Product assurance requirements selection and customization allow programs and projects to be successful in achieving their goals and the key is to use the expertise effectively, reflecting lessons learned and best practices to achieve the desired benefits, eliminating unnecessary expenses.

The word customization is used in the sense of personalization, adaptation, adequation. In this way, to customize is to adapt something according to the necessity. It is the process used to relieve the stringency of the product assurance requirements, consistent with the objectives of the program or project and with acceptable risks and restrictions. Customization does not require exemptions or deviations, but significant customizations must be documented in the documentation control system (NPR 7123.1C, 2020).

[1] Although customization is expected for all sizes of projects and programs, small projects present opportunities and challenges that are different from those of large traditional projects, such as the space shuttle, the International Space Station, the Hubble Space Telescope and the Mars Science Laboratory.

1.2 Problem

The major problem identified is finding a consistent methodology in the literature in which it is clear what the assurance requirements of the product should be applied to small satellites. This definition is important to ensure that space products fulfill their defined mission objectives in a safe, available and reliable manner. (Albuquerque, I. S, Brito, AC, Perondi, LF, 2020)

Product assurance, systems engineering and project management are essential disciplines for the development of systems for mission critical applications. In the space area, products are complex and a rigorous selection process for defining product assurance requirements is necessary. If correctly and consistently defined, they will ensure that the product is safe and reliable.

Space projects have their quality defined according to the mission's criticality. The more critical the mission, the more complex the management of product assurance requirements will be.

Thus, it can be said that the greater the number of interfaces, both managerial and technical (product), the greater the effort required to guarantee the product necessary for success in a given enterprise.

1.3 Objective

The objective of this work is to show the possibility of defining mission classes according to the level of risk exposure, the manufacturing time and cost, and the process for the selection of product assurance requirements

corresponding to each class, in order to obtain eventual gains in cost reduction or manufacturing time, in the development of missions according to the class in question. This article focuses on the selection and customization of the requirements of the product assurance disciplines allocated to the small mission class.

In order to achieve the objective of this article, the work was divided into two phases. The first phase, using the AHP-Sort method, will establish a ranking based on the mission risk, mission purpose and lifetime criteria, thereby making it possible to define the limits that establish the classes of satellites in the range A to D, TOR-2011 (8591) - 21, 2011

In the second phase, the Borda method will be used for ordering and ranking the requirements of each product assurance discipline. As described by Costa, H., G., (2014), McLean, (1990) and Barba-Romero, (1997). The main idea of this method is based on determining a combination of the individual ranking or ranking established by each of the decision makers in a global classification.

By making a selection and customization of the product assurance requirements associated with the execution of the project, it is possible, in principle, to generate gains in reducing costs and manufacturing time, as long as there are no impacts in the occurrence of non-conformities during the system, subsystems and equipments verification phases¹.

II. METHODOLOGY AND WORK ORGANIZATION

2.1. Methodology

According to studies carried out by Popper (2003), scientific research is based on the logic of empirical methodology since it is characterized as a continuous, systemic and reflective sequence that aims to acquire knowledge through research.

This research shows that for small satellites, as they normally involve low costs and shorter development times, there is, in principle, scope for implementing a strategy described below.

The methodology is divided into three phases:

a) problem definition - there is no methodology for selecting product assurance requirements for small satellites;

¹Upward part of the V diagram, reference of systems engineering.

b) bibliographic review - bibliographic review will be carried out on the classification of space missions and on product assurance requirements for space systems;

c) development of a proposal for the classification of space missions - work will be carried out to justify and define the classes of satellites and allocate quality requirements; In this phase of the work, a tool called "multicriteria of decision" (MCDA) will be used, which applies to situations in which several conflicting criteria need to be evaluated in order to make a choice between multiple alternatives.

The methodology proposed in this study essentially consists of a customization of product assurance requirements associated with the execution of the project, for small missions, in order to reduce the cost, the time of manufacture and / or the scope of the mission, without compromising its main objective. Thus, the basic premise for such requirements customization is that they do not affect the reliability of the system, fully preserving the systems engineering logic, in the sense that the system, subsystems and equipment requirements are all verified through testing.

To meet the objective, the application of AHP-Sort is used, which is a variation of the Analytic Hierarchy Process - AHP method. The use of AHP-Sort is indicated for classification and reduction of alternatives. In this work, some specifications defined by the stakeholders will be used, such as risk, lifetime and type of mission for the classification of satellites in classes A, B, C or D.

Once the classes of the missions are defined, the Bordamethod will be used to order and rank the requirements, of the product assurance disciplines with the aid of questionnaires, to be completed by specialists. These data will be compiled and the result will indicate which requirements will be applied to each class of satellite.

2.2. Work Organization

To achieve the objectives proposed for this work, it is necessary to have a detailed and complete understanding of the concepts and rules applicable to the theme of this study. Basic concepts and an adequate bibliographic review aim to solidify the terminology and applications used in the space program.

The Sections I to III present the Introduction, Context, Problem, Objective, Methodology, work organization and Bibliographic Review. Section IV shows the application of the AHP-Sort method and bordamethod while section V presents the conclusions of the article.

III. BIBLIOGRAPHIC REVIEW

3.1. Product assurance requirements

The European Cooperation for Space Standardization (ECSS), considers the Product Assurance a discipline to support risk management, ensuring that space products carry out their approved missions in a safe, available and reliable manner (ECSS -S - ST - 00C).

ECSS presents the Product Assurance disciplines for the development of a space system, unlike NASA (National Aeronautics and Space Administration), which has the Mission Assurance discipline. In this case, NASA is explicit in that it covers all other disciplines through the independent application of scientific principles, engineering principles, quality standards and program management in order to achieve the mission's success (TOR-2007 (8546)-6018 REV. B).

With regard to adapting Product Assurance Requirements for space products, ECSS standards provide guidelines for adapting their requirements based on criticality categories. Some studies present other criteria to adapt the development processes.

3.2. Mission assurance guidelines for A-D mission risk classes

The NASA document, TOR-2011 (8591) - 21, is a document product of the 2010-2011 government and industry program, whose objective was to develop guidelines for defining characteristic profiles of the mission assurance processes for a given class of spacecraft risk (A, B, C or D), so as to serve as a recommended technical baseline to meet program needs, based on programmatic constraints and mission needs. This document provides mission risk class A to D profiles for USA space programs, considering factors such as criticality to the strategic plan of a specific government agency, national significance, availability of alternative opportunities, success criteria, investment, lifetime, mission and other factors.

The guidelines TOR-2011 (8591) - 21 provided in this document will serve as input for the requirements documents assessed in relation to the technical cost factors of a specific acquisition, as well as for the quantified risk and mitigation strategies to define the program baseline and risk requirements to meet the stated objectives of the mission.

3.3. AHP-Sort: an AHP- based method for classification problems

The AHP is a useful and widespread method for decisions making and solutions for the choice and classification of problems (Arueira, 2014). However, it is not suitable for classifying problems. In addition, another practical limitation of AHP is that a large number of

alternatives implies in a large number of comparisons. This work uses AHP-Sort, a new variant of AHP, used to sort alternatives in a predefined ordered categories. According to Gujansky, (2014), in addition to this, the AHP-Sort requires much less comparisons than the AHP, which facilitates decision making on a scale. In this work, this approach is used to define and select the classes of satellites.

The main characteristics of profiles from risk classes A to D are described below:

- **Class A** - represents a mission with minimal practical risk, in which all possible ways are sought to reduce the program's risk exposure.
- **Class B** - it is low risk, with small commitments in applying mission assurance standards to balance programmatic trade-offs between minimum risk and lower cost for operating and demo systems.
- **Class C** - it represents moderate risk and transfers the government's burden of risk to the best practices of contractors for exploratory or experimental missions.
- **Class D** - represents the highest risk profile, usually for a year or less, on experimental missions, and completely changes the development to best contractor practices, with minimal government oversight.

3.4. Borda Method: sorting product assurance requirements

From the bibliographic study it has been concluded that applying the Borda Method in each of the disciplines of the Product Assurance, according to the ECSS, (2016), it is possible to define a ranking of the requirements allowing the selection of each assurance requirement of the product within the limits established for the satellite classes defined in the previous phase.

According to Silva, C., J. E. (2015) the Borda Method was presented by Jean-Charles Borda in 1781, in France, to be applied in committees composed of more than one individual (multidecisor problem). The central idea of this method is to establish a combination of the individual ranking or ranking established by each of the decision makers in a global ranking.

Within the scope of the ECSS standards (ECSS, 2016), the disciplines of product assurance are defined: 1) Quality Assurance (QA); 2) Product Assurance Management; 3) Electrical, Electronic and Electromechanical Components (EEE); 4) Processes, Materials, Mechanical Parts; 5)

Software Product Assurance; 6) Dependability and 7) Safety.

The QA discipline was selected for this article. The requirements of the QA discipline are distributed according to table 3.1.

Table 3.1 Quality Assurance requirements

1.	Personnel training and certification
2.	Control of critical items
3.	Non-conformity control system
4.	Traceability
5.	Metrology and calibration
6.	Handling, storage, transport and preservation.
7.	Qualification process
8.	Quality requirements for procurement
9.	Receiving and inspection activities
10.	QA requirements for manufacturing, assembly and integration
11.	Manufacturing readiness reviews
12.	Cleaning and contamination control
13.	Specific requirements for assembly and integration
14.	Logbooks
15.	QA requirements for acceptance and delivery
16.	Project reviews

IV. APPLICATION OF METHODS AND RESULTS

4.1. Application of the AHP-Sort Method

During the life cycle of a project, in the definition of the mission, some product requirements are established, and the most common are: lifetime, purpose of the mission and acceptable risk. In the generic example, the requirements in table 4.1 were randomly defined.

Table 4.1 - Definition of the main satellite requirements according to TOR-2011 (8591) - 21

	CLASS A	CLASS B	CLASS C	CLASS D
LIFETIME	>7 years	<7 years	<4 years	<1 year
MISSION	Operational	Demonstrative	Exploratory	Experiment
RISK	Minimum	Low	Moderate	High

To represent the problem, the hierarchical analytical structure of the problem was created with its criteria

(requirements) and alternatives (classes) for all the disciplines that are represented according to Figure 4.1.

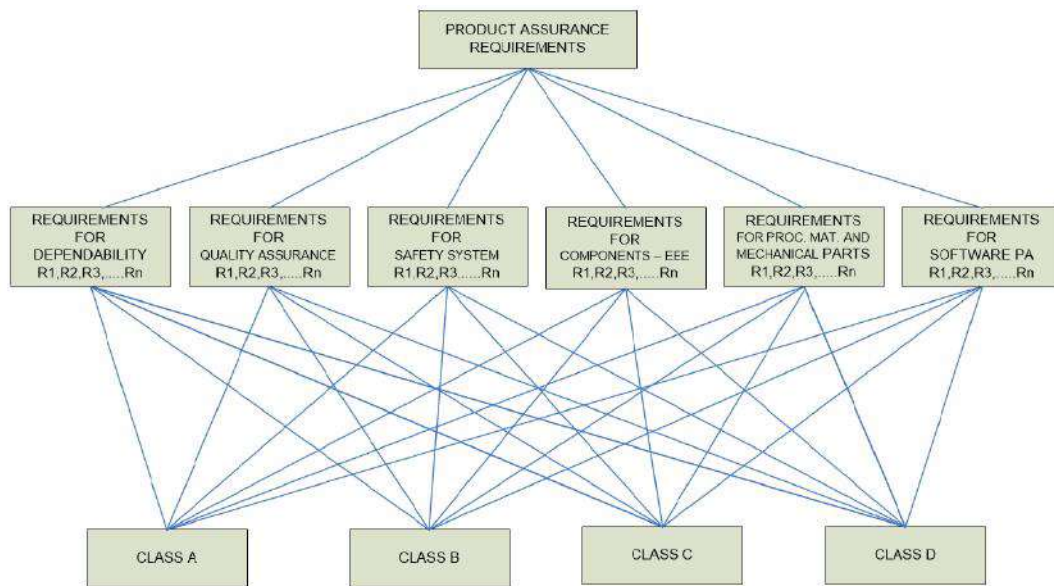


Fig. 4.1 - Analytical hierarchical structure of the problem

After defining the analytical structure of the problem, a study was carried out, as shown in Table 4.2, taking as an example four fictitious and random satellites in which three product assurance requirements have been applied: lifetime, mission and risk.

Table 4.2. Fictitious satellites

Alternative	Especification		
	Lifetime (years)	Mission	Risk
Satellite w	9	Operational	2,0
Satellite x	6	Demonstrative	3,0
Satellite y	4	Exploratory	7,0
Satellite z	1	Experiment	9,0

Figure 4.2 illustrates the AHP-Sort process that will be applied for the classification of the satellites defined in table 4.2.

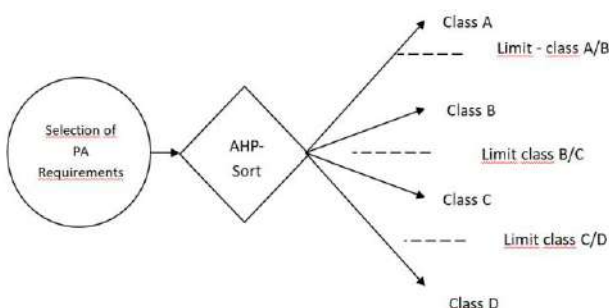


Fig. 4.2-AHP-Sort Process

Figure 4.3 shows the allocation of each requirement in the classes defined according to table 4.2.

	LIFETIME	MISSION	RISK
Class A	W 9 10 years	W 10 Operational	W 2 minimum (0)
Class B	X 6 7 years	X 7,5 Demonstrative	X 3 Low (2,5)
Class C	Y 4 4 years	Y 5 Exploratory	Y 7 Moderate (5)
Class D	Z 1 1 year	Z 2,5 Experiment	Z 9 High (7,5)

Fig. 4.3. Limiting Profiles for Each Class

To perform the pair-to-pair evaluation shown in Tabela 4.3, the fundamental Saaty scale was used.

Table 4.3. Fundamental scale of Saaty (1991), adapted by author of arueira, 2014.

The Fundamental Scale for Pairwise Comparisons		
Intensity of Importance	Definition	Explanation
1	Equal importance	Two elements contribute equally to the objective
3	Moderate importance	Experience and judgment slightly favor one element over another
5	Strong importance	Experience and judgment strongly favor one element over another
7	Very strong importance	One element is favored very strongly over another; its dominance is demonstrated in practice
9	Extreme importance	The evidence favoring one element over another is of the highest possible order of affirmation
Intensities of 2, 4, 6, and 8 can be used to express intermediate values.		

In this work, the SuperDecisions software, a Multicriteria Decision Support tool, will be used to structure and optimize the Performance Evaluation, generating organized results.

Figure 4.4. presents the SuperDecisions software screen indicating the relationship between the objective, criteria and alternatives

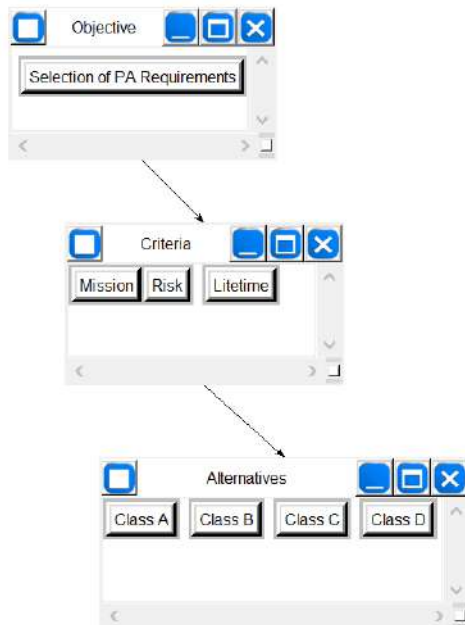


Fig. 4.4. Hierarchy presented by the SuperDecisions software.

According to Arueira (2014), the fundamental Saaty scale must be applied in the AHP method for the pair-by-pair comparison, the SuperDecisions software presents the table below, which is composed of three columns:

1. Choose - The degree of importance of each criterion is defined
2. Node Comparisons - Shows the pair-to-pair comparison
3. Results - This column shows the degree of importance of each criterion and also the value of the inconsistency of the judgment.

Inconsistency is an index that, according to Saaty, must be less than 0.1. In the example, 0.06239 was found, indicating that the comparison is acceptable. When this index is greater than 0.1 the comparison must be redone

The Figure 4.5. shown de *Pair-to-pair comparison of the criteria, using the Super Decisions software.*

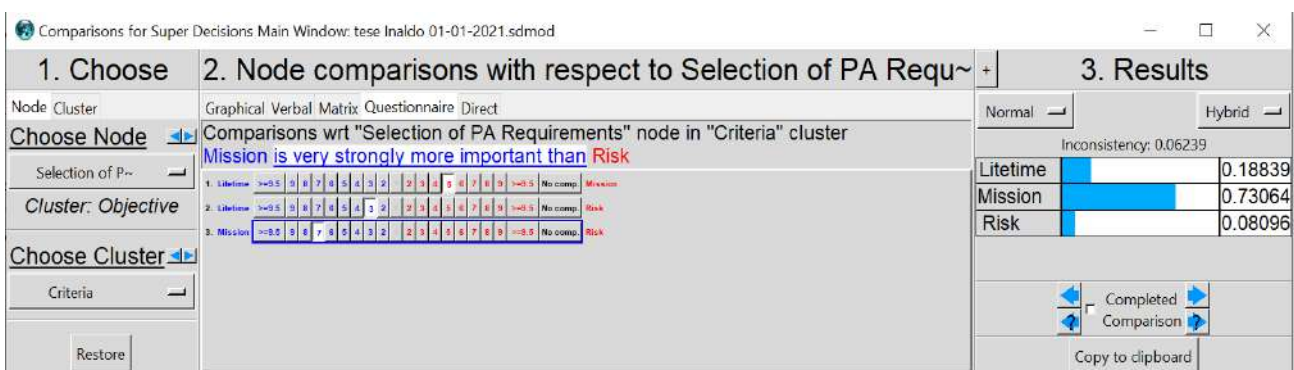


Fig. 4.5 Pair-to-pair comparison of the criteria, using the Super Decisions software

The Figure 4.6 shows the same result in matrix form

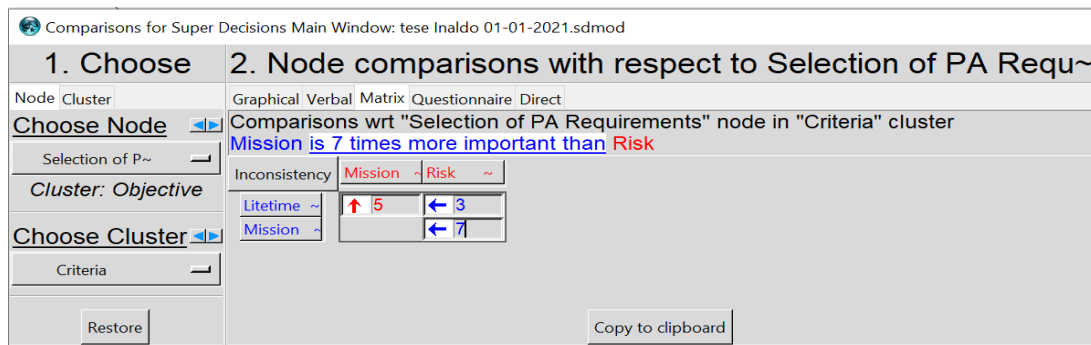


Fig. 4.6 Pair-to-pair comparison of the criteria, using the Super Decisions software

Next, it is necessary to judge the alternatives in relation to the limiting factors. In the exercise, the comparison matrix was judged by peers with all alternatives in relation to each of the limiting profiles of each class.

Using the data in table 4.1, a pair-to-pair comparison of the value of each alternative and the limiting profile of each class were performed.

Importance	Intensity	In favor of the alternative	In favor of the limiter
Equal	1	0,5000	0,5000
Small	2	0,6667	0,3333
Moderate	3	0,7500	0,2500
More moderate	4	0,8000	0,2000
Strong	5	0,8333	0,1667
More strong	6	0,8571	0,1429
Very strong	7	0,8750	0,1250
Much stronger	8	0,8889	0,1111
Extreme importance	9	0,9000	0,1000

Fig. 4.7. Values for judgments

The following table contains the complete judgment with all profiles and all classes in table 4.1.

Table 4.4 Judgments of the criteria in relation to the limiters

Alternative	>	Criteria (limits Class A/B)																																				
		Lifetime 7 years									Mission 7,5									Risk 2,5																		
Satellite x	6	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,75	6	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,3333333
Satellite w	9	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,6666667	9	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,6666667
Satellite y	4	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,3333333	2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,125
Satellite z	1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,1111111	1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,1111111
-																																						
Alternative	>	Critérios (limit Class B/C)																																				
		Lifetime 4 years									Mission 5									Risk 5																		
Satellite x	6	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,8	6	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,75
Satellite w	9	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,8571429	9	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,8333333
Satellite y	4	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,75	2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,1666667
Satellite z	1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,1666667	1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,1428571
-																																						
Alternative	>	Critérios (limit Class C/D)																																				
		Lifetime 1 year									Mission 2,5									Risk 7,5																		
Satellite x	6	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,8888889	6	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,8333333
Satellite w	9	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,9	9	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,8888889
Satellite y	4	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,8333333	2	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,75
Satellite z	1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,5	1	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	0,2
-																																						

After judging the criteria in relation to the limiting factors, the satellites were classified and, for that, it was necessary to aggregate the weighted local priorities that provide a global priority for each alternative, as an

attribution of the alternative to its class through the global priority. These steps were performed for each alternative to be classified according to Table 4.4.

Table 4.5. Evaluation for Satellite Classification

Alternative	Criteria (class A)			Limiting Escore	Alternative Score	Class
	Lifetime	Mission	Risk			
	0,18839	0,73064	0,08096			
Satellite x	0,75000	0,33333	0,33333	0,5882	0,4118	A
Satellite w	0,66667	0,66667	0,66667	0,3333	0,6667	
Satellite y	0,33333	0,16667	0,12500	0,8053	0,1947	
Satellite z	0,11111	0,11111	0,11111	0,8889	0,1111	
...						

Alternative	Criteria (class B)			Limiting Escore	Alternative Score	Class
	Lifetime	Mission	Risk			
	0,18839	0,73064	0,72905			
Satellite x	0,80000	0,66667	0,75000	0,3015	0,6985	B
Satellite w	0,85714	0,50000	0,83333	0,4057	0,5943	A
Satellite y	0,75000	0,25000	0,16667	0,6626	0,3374	
Satellite z	0,16667	0,16667	0,14286	0,8353	0,1647	
...						

Alternative	Criteria (class C)			Limiting Escore	Alternative Score	Class
	Lifetime	Mission	Risk			
	0,18839	0,73064	0,72905			
Satellite x	0,88889	0,85714	0,83333	0,1388	0,8612	B
Satellite w	0,90000	0,83333	0,88889	0,1496	0,8504	A
Satellite y	0,83333	0,75000	0,66667	0,2411	0,7589	C
Satellite z	0,50000	0,25000	0,20000	0,7070	0,2930	D
...						

As shown in table 4.6. –The evaluation for classification of satellites, the four satellites under study were identified and the following classification was obtained:

Table 4.6. Final satellite ranking

Satellite W	Class A
Satellite X	Class B
Satellite Y	Class C
Satellite Z	Class D

4.2. Borda Method: Ordering product assurance requirements

For the second part of the problem, we will use the Borda method for ordering the requirements of each product assurance discipline. The central idea of this method is to ranking established by each of the decision makers in a global ranking.

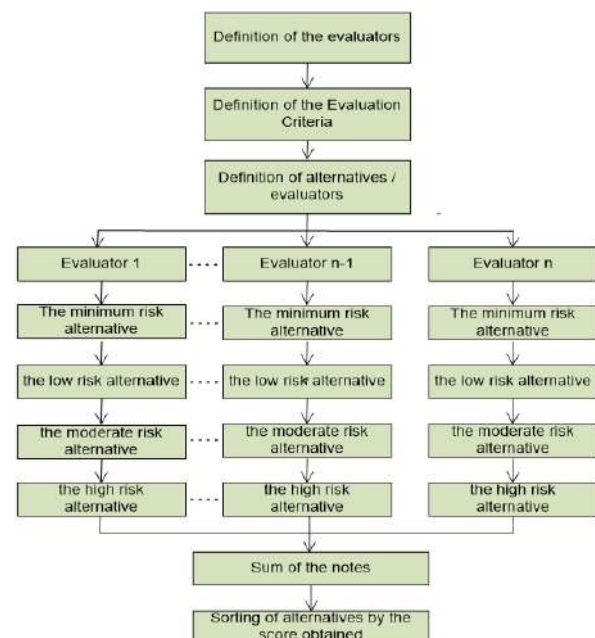


Fig. 4.8. Requirements ordering flowchart

The following steps are performed when applying the Borda method:

1. Define the evaluators or judges or members of the jury

2. Define the elements or alternatives to be ranked.
3. Obtain the assessments or judgments established by each decision maker for each of the alternatives.
4. Associate a score, order number or ranking score with each alternative, considering the individual judgments of each of the alternatives.
5. For each alternative, add the order numbers to obtain a global order number.
6. Obtain the final ordering of the alternatives, based on the global order numbers.

4.2.1. Borda Method: multidecision problem

According to Silva, (2015), to do the ranking, the Borda method will be used due to the simplicity and practicality of understanding the operations. After knowing this article in 1794, the French Academy of Sciences adopted the Borda method for counting the elections. This method remained in use until 1800, when it was discontinued.

Figure 4.9 presents the qualitative scale of the risk of the satellite mission objective. Using the risk values defined in this figure, an evaluation was carried out by three evaluators, whose result after being compiled allows to define which requirements should be allocated to each class of satellite.

Qualitative scale of mission risk	
A	Minimum risk mission
B	Low mission risk
C	Moderate mission risk
D	High mission risk

Fig. 4.9. Qualitative risk scale of the satellite mission objective

The flowchart steps in Figure 4.8 are described as follows:

1. The definition of the people who will participate as evaluators
2. The appraisers should be specialists in the space area, preferably with knowledge in systems engineering.
3. Definition of the evaluation criteria; Refer to Figure 4.9. "Quantitative Risk Scale for the Mission Objective" as a reference.
 - a) note 4: if the requirement analyzed offers a minimum risk to the mission, choose class A;
 - b) note 3: if the requirement analyzed offers a low risk to the mission, choose class B;
 - c) note 2: if the requirement analyzed offers a moderate risk to the mission, choose class C;
 - d) note 1: if the analyzed requirement presents a high risk for the mission, choose class D.
4. The appraiser must complete the spreadsheet with name, function, place of work and specialty, and vote on the alternatives by choosing the grade as defined in item 3;
5. The sum of the quantities of each type of evaluation will be carried out.
6. The result will be ordered reflecting the order of preference of the evaluators' alternatives.

In the proposed exercise, a total of three fictitious evaluators were used, as shown in table 4.7. The criteria were defined in item 4.2.1 and the product assurance requirements are described in Table 3.1. After the evaluators completed the questionnaires, the data were compiled and then the Borda method was applied. The results of each requirement were compiled and through a mathematical formula the satellite classes were defined for each requirement.

Table 4.7. Evaluation of Product Assurance requirements

EVALUATORS		EV 1				EV 2				EV 3				Evaluation Result				Allocation of requirements			
		CL A	CL B	CL C	CL D	CL A	CL B	CL C	CL D	CL A	CL B	CL C	CL D	CL A	CL B	CL C	CL D	CL A	CL B	CL C	CL D
1.	Personnel training and certification	4	3			4	3	2		4	3	2		4	3	2	0	A	B		
2.	Control of critical items	4	3			4	3			4	3			4	3	0	0	A	B		
3.	Non-conformity control system	4	3	2		4	3	2		4	3	2		4	3	3	0	A	B	C	
4.	Traceability	4	3	2	1	4	3	2	1	4	3	2	1	4	3	3	3	A	B	C	D
5.	Metrology and calibration	4	3	2	1	4	3	2	1	4	3	2	1	4	3	3	3	A	B	C	D
6.	Handling, storage, transport and preservation.	4	3	2	1	4	3	2	1	4	3	2	1	4	3	3	3	A	B	C	D
7.	Qualification process	4	3			4	3			4	3			4	3	0	0	A	B		
8.	Quality requirements for procurement	4	3			4	3			4	3			4	3	0	0	A	B		
9.	Receiving and inspection activities	4	3	2		4	3	2		4	3	2		4	3	3	0	A	B	C	
10.	QA requirements for manufacturing, assembly and integration	4	3	2		4	3	2		4	3	2		4	3	3	0	A	B	C	
11.	Manufacturing readiness reviews	4	3	2		4	3	2		4	3	2		4	3	3	0	A	B	C	
12.	Cleaning and contamination control	4	3	2		4	3	2		4	3	2		4	3	3	0	A	B	C	
13.	Specific requirements for assembly and integration	4	3	2	1	4	3	2	1	4	3	2	1	4	3	3	3	A	B	C	D
14.	Logbooks	4	3	2	1	4	3	2	1	4	3	2	1	4	3	3	3	A	B	C	D
15.	QA requirements for acceptance and delivery	4	3	2		4	3	2		4	3	2		4	3	3	0	A	B	C	
16.	Project reviews	4	3	2		4	3	2		4	3	2		4	3	3	0	A	B	C	

EV - Evaluators, CL - Class

Below is the synthesized result of the product assurance requirements and their applications in the satellite classes studied in this article.

Table 4.8. Classification of requirements in the appropriate classes of satellites

1.	Personnel training and certification	A	B		
2.	Control of critical items	A	B		
3.	Non-conformity control system	A	B	C	
4.	Traceability	A	B	C	D
5.	Metrology and calibration	A	B	C	D
6.	Handling, storage, transport and preservation.	A	B	C	D
7.	Qualification process	A	B		
8.	Quality requirements for procurement	A	B		
9.	Receiving and inspection activities	A	B	C	
10.	QA requirements for manufacturing, assembly and integration	A	B	C	
11.	Manufacturing readiness reviews	A	B	C	
12.	Cleaning and contamination control	A	B	C	
13.	Specific requirements for assembly and integration	A	B	C	D
14.	Logbooks	A	B	C	D
15.	QA requirements for acceptance and delivery	A	B	C	
16.	Project reviews	A	B	C	

V. CONCLUSIONS

In this chapter, the main conclusions of this work related to the obtained results will be exposed and closing with the suggestions for future works.

In a scenario where the demand for redesign and process improvement is greater than the available resources, it is essential to decide which processes are most critical for the execution of the strategy. This decision cannot be made by a single manager, since the reality in organizations is of increasingly complex and transversal processes, that is, executed by several organizational units, many of them positioned in different Directories.

It is well known that the space sector is strategic for the country's growth, and that is why a space program that aims to empower the country is necessary, but to circumvent this scenario of scarce investments, the alternative found is to build medium and small satellites

This work aims to develop a selection and customization process for product warranty requirements applied to medium and small space missions, aiming at gains in manufacturing time, scope or cost, without promoting any additional risk to the mission. With smaller weights and reduced sizes, these satellites are suitable for use in various applications.

For the realization of this article, the application of two simple and well-known methods was used.

The AHP-Sort method for classification problems where missions will be classified according to the accepted margin for project execution risk, defined by stakeholders. AHP-Sort's main function is to classify the satellite in classes A, B, C or D.

The Borda method is also used, whose main function is the ordering of quality assurance requirements. The great advantage is that both methods are very simple to use, thus offering a great advantage for the space program.

Finally, the proposed process will be documented and will become a reference for the application of the selection of the requirements actually necessary for each class of mission, thus avoiding the use of requirements that demand high cost when deploying on exploratory satellites however, without jeopardising the reliability of the mission.

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Application of economic and financial feasibility analysis in a residential condominium inside Amazonas

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Keywords— Economic viability,
Financial viability, Construction, Law
Suit.

Abstract— This work aims to highlight the relevance of the application of the economic and financial feasibility study in civil construction. And for contribution in the academic environment, as well as for the new civil construction companies, it is relevant to study and outline the planning until the execution of an economic and financial feasibility analysis, being that this study was carried out of a real enterprise, whose project was of a residential condominium in the interior of Amazonas, municipality of Iranduba. Starting from a feasibility study, using as a method, with regard to nature, an applied and quali-quantitative research was approached; as for the purposes, there was a bibliographic survey and interviews and data analysis and as for the means, it was classified as bibliographic, documentary and field. Data were collected from the construction company and developer in the development & new business sector. Some variables were addressed in the risk analysis, such as Cash Flow, Minimum Attractiveness Rate (TMA), simple and discounted Payback, Net Present Value (NPV), Internal Rate of Return (TIR) and Modified Internal Rate of Return (TIRM). The results showed that the studied enterprise is economically viable, and offers great potential. The simulation was carried out with the sale of 20% of the project's units by the tenth month of execution and the remainder until the completion of the work in the 38th month. The commercialization hypothesis resulted in a NPV of R \$ 702,043.50, an IRR of 1.91%, a discounted payback of 35.99 months and a profitability index of 1.10. Based on these data, it was possible to demonstrate as possible flaws in the execution of the project that there is a need to sell real estate in the plant, with the application of economic viability indicators in the project's cash flow in order to verify that the return on investment is better when the units are sold in a short period of time after the launch of the project. It was also understood the panorama in which this type of business is inserted and stands out as the biggest advantage, the initial investment. The scenarios proved to be profitable and consistent in terms of their financial health and an interesting alternative for the investor, since all the analysis methods applied showed a very positive result over the analyzed monthly periods, indicating a reasonably quick financial return.

I. INTRODUCTION

The economy of any country, in terms of local and global markets, is a vital indicator of the nation's well-being. High employment, business confidence and efficient use of natural and human resources contribute to a country's wealth. Investment is often the key to the success of a construction and government firm, policies and spending can have very real effects in terms of producing steady growth and minimizing the impact of recessions.

In the last few years, the construction industry in Brazil has undergone a strong transformation, from little investment to a lot of money being invested. This change was intensified mainly due to government investments, new laws that make it easier for investors to recompose unpaid houses and apartments, obtain new money on the stock exchange and the Brazilian Quality and Productivity Plan (PBQP-H) that was disseminated through industry concepts of total quality management. Because of this, new organization and models of technological innovation have been used by the industry (DIAS et al., 2020).

The construction industry consists of a very complex series of activities with different levels of complexity, which are linked to a very diverse number of products. Each product with different technological processes is linked to different types of demands. The sector has very intensive capital and technology segments such as cement, steel mills, etc. (FIESP, 2015).

There are also many Small and Medium Enterprises (SMEs) in services that have a small technological content. It can be said that in the civil construction sectors the main characteristic is to be very heterogeneous (Amorim, 2015; Mello, 2017). The construction industry is responsible for a very important portion of the Gross Domestic Product (GDP), participating with 13.8% (FIESP, 2015).

Civil construction is a very important sector of the economic scenario and is responsible for a salary amount of R \$ 15.5 billion, 5.2% of GDP, and approximately 9% of the employed population (IBGE, 2015). The industry's GDP is approximately R \$ 184.54 billion and the intermediate consumption value of this, according to the Getúlio Vargas Foundation (FGV, 2016), is approximately R \$ 181.69 billion. Almost 55.6% of the added value generated by the industry is due to the informal sector and 37% is due to the formal sector, which pays taxes of almost 45.69% (CBCC, 2015).

Despite a very unstable scenario in the last 5 years, we sought to present a theme that would satisfy academic and scientific issues, stressing that any major project involving engineering will probably require a lot of time, money and effort. Before making such a commitment, it is advisable

to carry out a feasibility study. Feasibility studies can make a difference, providing valuable project feedback and analysis, which can define how the project is managed, identify potential problems and even save money in the future. Before investing in a project, it is essential to conduct a feasibility study.

Given the above, the objective of this article is apply the economic and financial feasibility analysis in a Residential Condominium in the Interior of Amazonas.

II. LITERATURE REVIEW

2.1 INVESTMENT ANALYSIS

The activity of any company, in one way or another, associated with an investment of resources in various types of assets, the acquisition of which is necessary for the exercise of the main activity of this company is paramount. But to increase the company's profitability it can also invest resources temporarily available for various types of assets, revenues, but it does not participate in the essential activities. This activity is called an investment company, and management of such activities (investment management company), (AMORIM, LIMA and MURCIA, 2012).

Recently, the economy still did not have a clear understanding of holistic investment analysis as an independent field research within the framework of economic analysis. In the course of formulating and solving complex problems related to the problems of implementing long-term investments, analytical studies are necessary at the same time as financial, investment and operational decisions (DAMODARAN, 2010).

According to RAMOS and ZILBER (2015), the financial decision includes questions about which sources, to what extent and under which conditions long-term investments can be financed. Among the investments made is the allocation of own and borrowed resources among the possible areas of economic activity, certain types of assets, what is their structure, turnover period, the appropriate level of risk, etc.

According to SOUZA and CLEMENTE (2008), noting the importance of investment management, it is worth considering investment analysis itself as an independent branch of economic analysis. In addition, it should be presented as a project-oriented economic analysis, the implementation of which will depend largely on the needs of management decisions on specific investment options. The purpose of the analysis is not only an objective assessment of the adequacy of short- and long-term investment, but also the development of benchmarks for the company's investment policy.

In his work VEIGA (2012), he mentions that investment analysis is a process of evaluating the investment proposal to determine its profitability. It is the one that allows you to choose the best investment option by examining your risk, return and resale value. Investment analysis aims to find an investment that best fits a portfolio and adapts to the needs of the investor.

In this process, past investment returns and market trends are properly assessed to predict their future performance. Investment analysis is a very beneficial tool available to investors to identify the best investment option among several alternatives. It can be used to evaluate individual investment securities, large-scale business projects and for investment by startups. Fundamental and technical analysis are two important methods of investment analysis (VEIGA, 2012).

The objectives of the investment analysis according to SOUZA and CLEMENTE (2008), are:

- a) Integrated assessment of needs and availability of the necessary conditions for investment;
- b) Informed choice of financial sources and their prices;
- c) Identify factors (objective and subjective, internal and external) that affect the deviation from the real investment that results from the previously planned;
- d) Ideal investment solutions that strengthen the company's competitive advantage and are consistent with its tactical and strategic objectives;
- e) Suitability for investor risk and return parameters.

DAMODARAN (2010), reinforces that, based on the analytical study of the nature of managerial decision-making investments, projected investments and future cash flows are evaluated and compared. The analysis of general logic using formal criteria is to compare the magnitude of the investment required with the projected revenues. As the comparisons refer to different moments in time, it becomes a key question of comparability.

SOUZA and CLEMENTE (2008), also mention that the nature of the Investment Analysis consists of:

- i. Evaluate securities: the investment analysis examines the securities to choose the appropriate one. It is a tool that helps the investor to evaluate investment proposals before making any investment. The investment analysis aims to choose strategic investment plans that meet all objectives.
- ii. Measure risk and return: Measure risk and return on investment plans to determine your overall profitability. The level of risk to be assumed and the cash flows to be received are two important factors that are considered in

each project. Investors, through this process, can determine the profitability of different investment alternatives.

iii. Dealing with irreversible decisions: Investment analysis deals mainly with irreversible decisions that are long-term. These decisions affect an investor's earning capacity and growth rate. In case of any wrong decision, it can cause huge losses and adverse effects in the long run.

iv. Predict the future performance: This process is used to predict the future performance of the securities in order to know their credibility. Various graphing and information tools such as past returns, market trends, economic conditions, etc., are studied to estimate future returns.

v. Investor needs: The investment analysis aims to match the investment with the preferences and objectives of the investors. First, it adequately analyzes the capacity and individual requirements to perform the securities analysis. Projects are examined to ensure that they are suitable for the investor or not.

According to DAMODARAN (2010), the Investment Analysis Scope comprises:

- 1) Security of the principal: the investment analysis guarantees the security of the principal, adequately reviewing the stock before investing any amount. It assesses the risk involved in securities, which helps to reduce the risk of loss of capital and income.
- 2) Building a strong portfolio: choosing the right type of shares leads to the formation of a strong portfolio. Investment analysis studies different types of securities to find the one that best fits the portfolio. It focuses on combining the securities with the objectives of the portfolio to achieve the desired results.
- 3) Increase the return: the investment analysis has an efficient role in increasing the general return of the investors. Put more emphasis on the degree of risk involved and the amount of return to determine the profitability of the shares. Investment analysis helps you select investment plans with the most stable income and the lowest risk.
- 4) Transmitting financial knowledge: improves the general financial understanding of individuals looking for a strategic investment plan. When evaluating titles, several tools and techniques are used, which provides a lot of useful information. This information allows the investor to make rational investment decisions with the best return and minimum risk.

2.2 ECONOMIC AND FINANCIAL FEASIBILITY STUDY

Economic and financial analysis during the design, evaluation and implementation of the project plays a key role in obtaining the desired economic results and in increasing the likelihood of sustained economic benefits from a project (KASSAI, 2015).

According to HOJI (2013), the main objective of financial analysis is to examine the financial returns for project participants (beneficiaries, project entity, institutions and governments), in order to demonstrate that all actors have sufficient financial incentives to participate. Economic analysis is carried out to assess the efficiency of projects in terms of their net contribution to national economic and social well-being.

Economic and financial analysis of investment projects is an assessment requirement of most governments and Financing Institutions. It provides the basis for decision making on investment financing for a proposed project based on its financial and economic viability. Although Financial Institutions and governments require that economic and financial analysis be conducted in the project evaluation phase, it is also increasingly considered to be an important instrument for the identification, design, implementation and ex post evaluation of investment programs and projects (RAMOS and ZILBER, 2015).

For HOJI (2013), the study of economic and financial viability begins with the analysis of the main objectives and goals of the proposed project that need to be reflected in the logical structure of the project. This is followed by the monetization of the relevant benefits of the project and its associated costs. This study basically consists of two main steps: first, an assessment of the project's financial profitability and sustainability to determine whether other stakeholders will have sufficient incentives to participate in the project; and, second, an assessment of its economic viability from the point of view of the national economy.

The economic and financial feasibility study should also examine the expected impact of a project on the government's budget to ensure its fiscal sustainability. In addition, it usually includes an assessment of the impact of a project on employment and poverty, as well as an analysis of the distribution of benefits (HOJI, 2013).

The stage of determining the viability indicators covers the decision of which indicators will be used in the investment analysis process, the most common being: the net present value (NPV), the internal rate of return (IRR), the minimum rate of attractiveness (TMA) and investment payback (KASSAI, 2015).

After determining the indicators, they must be analyzed considering, among so many variables, the objectives and structure of the organization that intends to implement or produce this innovation, as the viability must meet the demands of the organization and this involves not only questions of economic and financial values, but also the interest in taking the risk of investing in the new product or project (ROSS et al., 2012).

As highlighted by LOCATELI (2015), when defining the methods of economic engineering analysis for investments in facilities, it is important to emphasize that not all impacts on facilities can be easily estimated.

Companies can choose to minimize the environmental impacts of construction or facilities in search of a triple financial result: economic, environmental and social. By reducing environmental impacts, the company can reap the benefits of an improved reputation and a more satisfied workforce. However, a rigorous economic assessment can help in making decisions for quantifiable and qualitative impacts of the facilities (LOCATELI, 2015).

According to LOCATELI (2015), it is important to distinguish between the economic evaluation of alternative physical facilities and the evaluation of alternative financing plans for a project. The first refers to the cash flow assessment that represents the benefits and costs associated with the acquisition and operation of the facility, and this cash flow over the planning horizon is called economic cash flow or operating cash flow. The latter refers to the assessment of the cash flow that represents income and expenses as a result of the adoption of a specific financing plan to fund the project, with this cash flow in the planning horizon called financial cash flow.

For LOCATELI (2015), the economic and financial evaluation are carried out by different groups in an organization, since the economic evaluation is related to the design, construction, operations and maintenance of the installation, while financial evaluations require knowledge of financial assets, such as stocks, bonds, notes and mortgages.

The separation of economic and financial assessment does not necessarily mean that one must ignore the interplay of different projects and funding requirements over time, which can influence the relative suitability of specific project / funding combinations. In practice, however, the division of labor between two groups of specialists generally leads to sequential decisions without adequate communication to analyze the interaction of various design / financing combinations due to the time of separate analyzes (LOCATELI, 2015).

As long as the importance of the interaction of design / financing combinations is understood, it is convenient to first consider the economic assessment and the financial assessment separately and then combine the results of both assessments to reach a final conclusion (BRAGA, 2019).

III. METHODOLOGY

The methodology used to obtain the results of the research that had been developed and carried out, estimates a more adequate path for the understanding and resolution of the pointed out problem. Thus, for better understanding, the objective of this study is to apply the analysis of economic and financial feasibility in a Residential Condominium in the Interior of Amazonas.

The studied enterprise is located in Iranduba, which is a municipality in the state of Amazonas, belonging to the metropolitan region of Manaus and the central Amazon region. According to the Brazilian Institute of Geography and Statistics (IBGE) the population of the municipality is 48,250 inhabitants, which places the municipality as the 11th most populous in Amazonas. The municipality is located on the left bank of the Rio Solimões, at the confluence with the Rio Negro, located south of Manaus. See figure 1.



Fig. 1: Map of the municipality of Iranduba.

Source: Google Maps (2020).

The project is located in the Ramal da Prainha, Cacau Pirera neighborhood, 150 meters from the Manoel Urbano Highway, kilometer three, approximately 20 minutes from the center of Manaus, a relatively short time compared to the distance between the city center and other regions, such as the North Zone (35 minutes), and the East Zone (40 minutes). The route to the development is surrounded by nature, allowing the resident to decompress the stress of everyday life, see figure 2.



Fig. 2: Location of the development.

Source: Google Maps (2020).

To carry out the data survey, this research used various materials and internal information from the construction company, as the research was a case study, there was a data survey, analysis and improvement proposal. In such a way that the schematic order of the study is detailed according to the flowchart shown in figure 3.

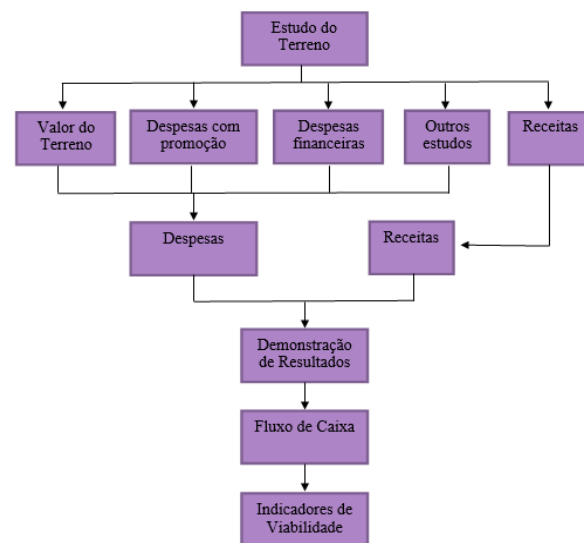


Fig. 3: Flowchart of the study steps.

Source: Adapted by the authors (2020).

When starting a project launching process and subsequently analyzing the results, the study of the land is first analyzed, that is, the company maps the land in the city and observes possible points of interest, in the case of the studied company, generally the construction company is the one who arouses the interest of the landowner's sale, through direct negotiation of purchase and sale, this fact explains the best launching locations in the cities.

The location, dimensions, need for deforestation are checked, that is, if all criteria are suitable for the type of

property, if the land analyzed, fits a low, medium or high standard condominium.

After this verification, the data from the economic and financial feasibility study were collected, in this way, the value of the land was determined through direct negotiation, survey of all expenses and values adopted through predetermined premises; in the case of the construction company studied, data were collected on works already carried out to project total expenses.

Expenses with preliminary studies are related to costs with projects, decorations, sales stands and architecture. Concomitantly, the sale price was determined, generally linked to the cost of architecture, as the architecture and leisure items in the condominium resulted in the property's standard, being low, medium and high standard.

The enterprise under study fits in medium standard, because it is a property with two bedrooms, with 42m² of built area, selling price around one hundred and sixty thousand reais (R\$ 170,000.00), closed condominium, with an area common room, party room and swimming pool.

Finally, the income statement and cash flow projection were calculated to analyze economic viability indicators and determine the project. In a feasibility study, this is the best time to carry out a project's decision making, as the construction company or developer had no cost, making the feasibility study very relevant for the construction companies.

IV. RESULTS AND DISCUSSION

4.1 SCENARIO ANALYSIS

The economic crisis that occurred in mid-2014 in Brazil, resulted in one of the strongest economic recessions in the country, there was a decline in GDP (Gross Domestic Product) for two consecutive years and generated a high rate of unemployment, with a rate 14% per year, which represented 14.5 million unemployed Brazilians.

The civil construction sector was the most affected by the crisis, which had previously registered high growth rates between 2009 and 2014, but has shut down one (01) million workers since the beginning of the recession; during the economic crisis process, few activities suffered more than civil construction. However, Civil Construction in Brazil has been showing great growth.

The sector is heated by high consumer demand, easy access to credit and government subsidies. These factors have ensured a good level of sales and a considerable increase in prices over the past few months, according to a survey conducted by CBIC, real estate indicators had a

considerable increase in the quarters of 2019 compared to the quarters of 2018, with regard to residential units launched by region, as shown in figure 4.

REGIÃO PESQUISADA	1º TRIMESTRE DE 2018	2º TRIMESTRE DE 2018	3º TRIMESTRE DE 2018	4º TRIMESTRE DE 2018	1º TRIMESTRE DE 2019	2º TRIMESTRE DE 2019	3º TRIMESTRE DE 2019	VARIACÃO (%) TRIMESTRE ANTERIOR	VARIACÃO (%) TRIMESTRE ATUAL E ANTERIOR
NORTE	0	900	1.228	300	220	900	1.756	95,1%	43,0%
NORDESTE	6.063	5.844	5.485	4.276	4.502	2.955	4.565	54,5%	-16,8%
CENTRO-OESTE	657	2.077	1.453	2.756	1.598	3.649	2.236	-38,7%	53,9%
SUDESTE	6.874	15.844	14.075	30.373	7.441	21.942	21.054	-4,0%	49,6%
SUL	1.242	3.759	4.558	3.008	3.203	2.435	3.588	47,4%	-21,3%
TOTAL	14.836	28.424	26.799	40.713	16.964	31.881	33.199	4,1%	23,9%

Fig. 4: Residential units launched by region.

Source: CBIC / CII (2020).

According to Figure 4, an index that stood out was the variation of the last quarter compared to the penultimate quarter of 2019 in the North region, which had an increase of 95.1%, such result shows that the builders and developers believe in the potential and development of the region. Another survey shows the accumulated 12 months of residential units launched in the country, which also confirms the constant increase and good prospects for civil construction, as shown in figure 5.



Fig. 5: Accumulated 12 months of residential units launched.

Source: CBIC / CII (year).

Studies claim that since the last economic crisis, the sector has been suffering in its performance and going through a process of stagnation, according to research carried out by the Brazilian Institute of Geography and Statistics (IBGE), the loss indicators show worrying results, as shown in figure 6.



Fig. 6: Accumulated variation since the beginning of the crisis.

Source: IBGE.

However, in the last few months, the sector's expectations in the economy have been improving, with the Minha Casa Minha Vida Program, maintained by the new federal government and called "Casa Verde e Amarela" and the release of subsidies for middle and low-income families. Civil construction is reheating the market, builders and developers are recovering and business confidence has improved in recent months, another survey carried out by the Brazilian Institute of Geography and Statistics (IBGE) demonstrates confidence in the construction sector, as shown in figure 7.



Fig. 7: Construction sector confidence indices (in points).

Source: IBGE.

4.2 PROJECT COSTS

Costs can be analyzed in Figure 8.

RESUMO DAS CONTAS				\$/1000
Data Base: Agosto /2019		Total Indexado	Total VP	%GVV
Venda de Unidades		54.000	42.893	100,0%
Receita c/ Vendas	54.000	42.893	100,0%	
Outras Receitas	4.200	3.477	7,8%	
Retorno de Aporte DM CEF	4.200	3.477	7,8%	
Despesas c/ Financiamento	85	66	0,2%	
TAO	80	62	0,1%	
Juros PJ	5	4	0,0%	
Terreno	5.766	4.675	10,7%	
Permuta Financeira	4.467	3.548	8,3%	
IPU	121	96	0,2%	
Pagamento de Terreno (R\$)	788	763	1,5%	
ITBI	95	94	0,2%	
Correção Monetária	295	174	0,5%	
Obra	25.384	20.010	47,0%	
Custo de Obra Raso	23.822	18.860	44,1%	
Assistência Pós-Obra (%)	357	220	0,7%	
Projeto (R\$)	270	226	0,5%	
Seguro (Obra)	191	160	0,4%	
Não Incidentes/Habite-se	120	95	0,2%	
INCC/DIObra Raso	624	448	1,2%	
Despesas Comerciais	5.928	4.898	11,0%	
Comissão s/ Venda	2.322	1.855	4,3%	
Propaganda (% Propaganda)	1.080	931	2,0%	
Relacionamento com Cliente	270	187	0,5%	
ITBI e Registro Unidades	1.716	1.451	3,2%	
Stand de Vendas: Construção	270	248	0,5%	
Stand de Vendas: Custo Fixo	270	226	0,5%	
Incorporação	3.790	3.043	7,9%	
Taxa de Administração s/ Carteira	2.700	2.145	5,0%	
Desp. de Incorporação (R\$)	1.090	899	2,0%	
Outras Despesas	4.200	3.525	7,8%	
Aporte p/ Demanda Mínima CEF	4.200	3.525	7,8%	
Impostos	2.160	1.700	4,0%	
RET	2.160	1.700	4,0%	
Saldo	10.887	8.452	20,2%	

Fig. 8: Project Costs.

Source: Case study, 2019.

4.3 BALANCE SHEET

The balance sheet is a report version of the accounting equation, in which assets always equal liabilities plus equity capital. Investors and creditors often analyze the balance sheet and infer about how efficiently a company can use its resources and how effectively it can finance them.

Balance sheet analysis can reveal a lot of important information about a company's performance. The importance of the balance sheet is listed below:

- It is an important tool used by investors, creditors and other interested parties to understand the financial health of an entity.
- The growth of an organization can be known by comparing the balance sheet for different years.
- It is an essential document that must be sent to the bank to obtain a commercial loan.
- Stakeholders can understand the entity's business performance and liquidity position.
- The ability to carry out expansion projects and meet unforeseen expenses can be determined by analyzing the company's balance sheet

- If the company is financing its operations with profit or debt, it can be known.

Table 1 presents the data related to the Balance Sheet (assets and liabilities) of the project under study.

Table 1 - Balance Sheet.

BALANÇOS PATRIMONIAL EM 31 DE DEZEMBRO DE 2019			
VALORES EM REAIS (R\$) SEM CENTAVOS			
ATIVO		PASSIVO	
ATIVO CIRCULANTE		PASSIVO CIRCULANTE	
	7,936,088		6,829,341
Caixa e Equivalente de caixa	2,471,777	Contas a pagar a fornecedores e outras	1,571,914
Contas a receber de clientes e outras	4,706,581	Obrigações trabalhistas e sociais	291,479
Estoques	278,809	Obrigações por aquisição de terrenos e adiantam. de clientes	4,544,116
Tributos a recuperar	42,798	Contratos cancelados	61,438
Outros ativos	436,123	Empréstimos e financiamentos	5,905
		Obrigações com pessoas ligadas	
		Obrigações tributárias	347,479
		Outros passivos	7,010
ATIVO NÃO CIRCULANTE		PASSIVO NÃO CIRCULANTE	
	5,269,914		535,509
Créditos com pessoa ligadas	5,208,185	Tributos diferidos	212,970
Imobilizado	61,729	Provisões	322,539
		Outras obrigações financeiras	-
		PATRIMÔNIO LÍQUIDO	5,841,152
		Capital Social	1,000

		Subscrito	
		Reservas	5,840,152
TOTAL	13,206,002	TOTAL	13,206,002

Source: Case study, 2019.

4.4 STATEMENT OF INCOME FOR THE YEAR

With the Statement of Income for the Year (DRE), leaders and managers at different levels can have concrete knowledge about the company's profit or loss and, consequently, act in order to reverse the negative scenarios in time.

The DRE is more than a report that briefly demonstrates the operations carried out by the company. In it, the accounts of revenue, expenses, investments, costs and provisions are compared, showing the formation of the company's net result at the time.

For legal purposes, the income statement is made annually, but simplified monthly income statement for administrative purposes and quarterly income statement for the monitoring of tax expenditures can be made. The DRE Report must be prepared respecting the accrual basis, that is, depending on the occurrence of the event that generates the accounting record, regardless of the actual receipt of the revenue or the payment of the expense.

Table 2 illustrates the DRE of the project under study.

Table 2 - Income Statement.

LUCRO ANTES DOS EFEITOS FINANCEIROS	4,711,940
OUTRAS RECEITAS FINANCEIRAS	99,815
Custos de financiamento	- 76,107
Receitas de investimentos	175,922
LUCRO ANTES DA TRIBUTAÇÃO	4,811,755
TRIBUTOS SOBRE O LUCRO	- 541,540
Contribuição Social Corrente	- 18,056
Contribuição Social Diferida	- 169,071
Imposto de Renda Corrente	- 31,641
Imposto de Renda Diferido	- 322,772
LUCRO DO EXERCÍCIO	4,270,215
LUCRO LÍQUIDO DO EXERCÍCIO	4,270,215
RESULTADO ABRANGENTE TOTAL DO EXERCÍCIO	4,270,215

Source: Case study, 2019.

4.5 CASH FLOW

Cash Flow is of fundamental importance for companies, constituting an indispensable signaling of the financial direction of the business and providing the administrator with a future view of the company's financial resources, it is built from information related to all expenditures and income inflows. already known and projected boxes.

In order to prepare the Cash Flow, the company needs to have internally organized information that allows viewing of accounts receivable, accounts payable and all disbursements that generate fixed costs.

The way to obtain and organize this auxiliary information involves the use of management tools, the form of which will depend on the type of company, its size and financial availability.

Cash Flow is a large information system to which the financial data generated in different areas of the company converge. The biggest difficulty in having a really effective cash flow is to properly manage this information system.

The cash flow statement will not only serve for the realized flow, but also for projection. The manager will be able to simulate the resources and expenses planned for a given period, thus being able to more easily predict when there will be a cash deficit or surplus.

In accordance with these financial assumptions, a cash flow statement was prepared, projected for the first five years of operation. The items of revenue and disbursement, costs and expenses were classified in operating, investing and financing activities.

Operating activities are those intrinsic to the industry: monthly and usual income and expenses.

Investment activities include those necessary for structuring the business: purchase of furniture, utensils, installations and equipment, as well as works referred to the operation of the business.

The financing activities are those necessary to obtain the financial resources and which allow a positive cash balance each month, as well as amortization of the financing obtained, as shown in table 3.

Table 3 - Cash flow.

DEMONSTRAÇÃO DE FLUXO DE CAIXA EM 31 DE DEZEMBRO DE 2019	
VALORES EM REAIS (R\$) SEM CENTAVOS	
DAS ATIVIDADES OPERACIONAIS	
LUCRO LIQUIDO ANTES DO IR E CSLL	4,811,756

Ajustes para conciliar o resultado às disponibilidades geradas pelas atividades operacionais	
Depreciação e amortização	255,959
Custos de financiamento	76,107
Renda de investimento reconhecida no resultado	- 175,922
LUCRO LIQUIDO AJUSTADO	4,967,900
Variação do capital circulante	
Acréscimo/Decréscimo nas contas a receber de clientes e outras	- 112,262
Acréscimo/Decréscimo nos estoques	2,438,618
Acréscimo/Decréscimo nos tributos a recuperar	33,400
Acréscimo/Decréscimo em outros ativos	5,032,369
Acréscimo/Decréscimo nas contas a pagar a fornecedores e outras	2,084,778
Acréscimo/Decréscimo nas obrigações trabalhistas	202,485
Acréscimo/Decréscimo nas obrigações tributárias	251,956
Acréscimo/Decréscimo nos tributos diferidos passivos	- 89,073
Acréscimo/Decréscimo em outros obrigações financeiras	- 9,449
Acréscimo/Decréscimo nas provisões para contingências	179,063
Acréscimo/Decréscimo nos demais passivos	56,550
CAIXA PROVENIENTE DAS OPERAÇÕES	802,039
Imposto de renda e contribuição social sobre o lucro	- 541,540
CAIXA LÍQUIDO PROVENIENTE DAS ATIVIDADES OPERACIONAIS	260,499
DAS ATIVIDADES DE INVESTIMENTOS	
Juros, royalties e outras receitas de investimento recebidos	175,922
Aquisição de imobilizado	- 2,118
CAIXA LÍQUIDO PROVENIENTE DE ATIVIDADES DE INVESTIMENTOS	173,804
DAS ATIVIDADES FINANCEIRAS	
Novos empréstimos	5,905
Juros sobre financiamentos	- 76,107
Empréstimos de partes relacionadas	- 753,383

CAIXA LIQUIDO PROVENIENTE DE ATIVIDADES DE FINANCIAMENTOS	- 823,585
VARIAÇÃO DAS DISPONIBILIDADES	- 389,282
DEMONSTRAÇÃO DA VARIAÇÃO DAS DISPONIBILIDADES	
Saldo inicial das disponibilidades	2,861,059
Saldo final das disponibilidades	2,471,777
	- 389,282

Source: Case study, 2019.

The simulation (Figure 9) was carried out with the sale of 20% of the project's units by the tenth month of execution and the remainder until the completion of the work in the 38th month.

n	Etapa %	Vendas	Receitas	Custos	Fluxo	Fluxo descontado	VPL
0				1.375.183,00	-1.375.183,00	-1.375.183,00	-1.375.183,00
1	4,85	0,00	0,00	308.117,81	-308.117,81	-304.644,86	-1.679.827,86
2	4,85	0,00	0,00	308.117,81	-308.117,81	-301.211,05	-1.981.038,91
3	3,06	0,00	0,00	194.400,10	-194.400,10	-187.900,37	-2.168.939,28
4	1,49	0,00	0,00	94.658,87	-94.658,87	-90.462,70	-2.259.401,98
5	3,68	0,00	0,00	233.788,36	-233.788,36	-220.906,32	-2.480.308,30
6	2,39	0,00	0,00	151.835,37	-151.835,37	-141.851,94	-2.622.160,23
7	4,35	0,00	0,00	276.353,09	-276.353,09	-255.272,29	-2.877.432,52
8	2,36	0,00	0,00	149.929,49	-149.929,49	-136.931,53	-3.014.364,06
9	2,75	0,00	0,00	174.705,97	-174.705,97	-157.761,57	-3.172.125,62
10	2,99	2.200.000,00	720.940,00	328.153,04	392.786,96	350.693,38	-2.821.432,24
11	3,50	220.000,00	156.794,00	237.253,06	-80.459,06	-71.026,84	-2.892.459,09
12	3,25	220.000,00	165.594,00	221.370,70	-55.776,70	-48.683,01	-2.941.142,09
13	2,82	220.000,00	167.596,00	194.053,04	-26.457,04	-22.831,94	-2.963.974,03
14	2,67	220.000,00	175.384,00	184.523,62	-9.139,62	-7.798,42	-2.971.772,46
15	3,66	220.000,00	219.802,00	247.417,77	-27.615,77	-23.297,69	-2.995.070,15
16	3,58	220.000,00	233.090,00	242.335,41	-9.245,41	-7.711,86	-3.002.782,01
17	3,39	220.000,00	241.736,00	230.264,82	11.471,18	9.460,58	-2.993.321,43
18	3,60	220.000,00	264.968,00	243.606,00	21.362,00	17.419,22	-2.975.902,20
19	2,40	330.000,00	298.452,00	174.220,67	124.231,33	100.160,18	-2.875.742,02
20	1,94	330.000,00	293.040,00	144.997,12	148.042,88	118.012,64	-2.757.729,38
21	2,43	330.000,00	330.099,00	176.126,55	153.972,45	121.355,95	-2.636.373,43
22	1,61	330.000,00	302.841,00	124.032,41	178.808,59	139.342,47	-2.497.030,96
23	2,18	330.000,00	345.444,00	160.244,19	185.199,81	142.696,30	-2.354.334,66
24	1,82	330.000,00	338.448,00	137.373,59	201.074,41	153.181,39	-2.201.153,27
25	1,17	330.000,00	309.705,00	96.079,45	213.625,55	160.908,68	-2.040.244,59
26	0,88	330.000,00	298.287,00	77.655,91	220.631,09	164.312,28	-1.875.932,31
27	1,32	330.000,00	334.587,00	105.608,87	228.978,13	168.606,53	-1.707.325,79
28	1,15	330.000,00	330.957,00	94.808,86	236.148,14	171.926,15	-1.535.399,63
29	1,16	330.000,00	339.306,00	95.444,16	243.861,84	175.540,90	-1.359.858,73
30	1,15	330.000,00	346.170,00	94.808,86	251.361,14	178.899,72	-1.180.959,02
31	1,52	330.000,00	384.285,00	118.314,76	265.970,24	187.163,70	-993.795,32

Continua...

(Conclusão)

n	Etapa %	Vendas	Receitas	Custos	Fluxo	Fluxo descontado	VPL
32	1,61	330.000,00	402.039,00	124.032,41	278.006,59	193.428,61	-800.366,70
33	1,58	330.000,00	409.992,00	122.126,52	287.865,48	198.030,58	-602.336,12
34	1,28	330.000,00	392.700,00	103.067,69	289.632,31	197.000,23	-405.335,89
35	1,27	330.000,00	400.191,00	102.432,40	297.758,60	200.244,73	-205.091,16
36	1,42	330.000,00	423.423,00	111.961,81	311.461,19	207.098,89	-2.007,72
37	2,05	330.000,00	497.244,00	151.985,36	345.258,64	226.984,10	228.991,82
38	10,82	330.000,00	1.436.886,00	709.138,60	727.747,40	473.051,68	702.043,50

Fig. 9: Simulation

Source: Case study, 2019.

The aforementioned commercialization hypothesis resulted in a NPV of R \$ 702,043.50, an IRR of 1.91%, a discounted payback of 35.99 months and a profitability index of 1.10.

Table 4 highlights the results of the financial indicators found in the proposed simulation.

Table 4 - Result of the Simulation Financial Indicators.

Simulação	
Período de Comercialização	10-38
VPL	702.043,50
TIR	1,91%
Payback descontado	35,99
Índice de Lucratividade	1,10

Source: Case study, 2019.

In the financial market, there is the possibility of raising funds with a nominal rate of 8.5% a.a. + TR (The value of TR in October 2019 was approximately 0.2% a.m.) Which generates an equivalent rate of 0.88% a.m.

The interest rate described refers to Caixa Econômica Federal's "Production Support" credit method, which has a 36-month term for the project and can be extended for a further 6 months and an amortization term of 24 months, in the period of construction, only interest corresponding to the amounts received is paid.

Sales made through housing financing are automatically amortized in the referred financing and in cases of cash sale of the units, the value corresponding to them must be amortized from the financing by the construction company. In other words, fundraising by third parties is feasible because it presents a lower index than the IRR and lower than the yield on financial investments that have a net yield of 0.93% a.m. when the redemption occurs after two years due to the 15% income tax levied on profitability

V. CONCLUSION

At the end of the work and given the data presented and the results achieved, it is evident that the enterprise, despite all the economic and financial instability in which the country is facing, is still a viable alternative and a model to be implemented by entrepreneurs.

In the course of the work, it was possible to highlight the details of the project, especially in the methodology chapter, and costs involved in the elaboration (presented in the results chapter);

With the data obtained in the case study, it was possible to analyze the economic and financial risk indicators as well as present the Cash Flow, Ebtida, NPV (Net Present Value), IRR (Internal Rate of Return), TIRM (Internal Rate of Return) Modified Return) and Payback to identify and evaluate the project's viability. A simulation was carried out with the sale of 20% of the project's units by the tenth month of execution and the remainder until the completion of the work in the 38th month.

According to the simulation carried out, it was verified that the project is viable, given that the commercialization hypothesis above resulted in a NPV of R \$ 702,043.50, an IRR of 1.91%, a discounted payback of 35.99 months and a profitability index of 1.10.

Based on these data, it was possible to demonstrate as possible flaws in the execution of the project that there is a need to sell real estate in the plant, with the application of economic viability indicators in the project's cash flow in order to verify that the return on investment is better when the units are sold in a short period of time after the launch of the project.

It was also understood the panorama in which this type of business is inserted and stands out as the biggest advantage, the initial investment. The scenarios proved to be profitable and consistent in terms of their financial health and an interesting alternative for the investor, since all the analysis methods applied showed a very positive result over the analyzed monthly periods, indicating a reasonably quick financial return.

The present risks cannot be completely eliminated, the monitorable risks are those that can be controlled; however, non-monitorable risks, such as interest on the economy, cannot be eliminated, they can be reduced with a careful analysis of market trends.

Compared with financial market applications, investment becomes unfeasible when the units are sold only at the end of the work or even after completion, that is, it is essential to sell the properties on the plant to increase the return on investment.

The real estate market is always competitive and requires creativity, persistence and audacity to face your difficulties. In the search for evidence in the respective sector, it is extremely important to know the industry, the market segment in which it operates, its competitors, target audience among other factors, especially those related to financial and economic issues. The set of these elements, with the aid of Microeconomic tools, can clearly provide the sector's strengths and weaknesses, how much it can grow and support market offers, in addition to how prepared it must be to achieve maximum success. in business.

Thus, it is suggested that more studies in this segment can be carried out, since there was also a scarce literature on the theme presented, and further discussions about the economic and financial viability of real estate developments should be stimulated and encouraged.

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Assessment of the Impairment in Domain functionalities and Executive Functions in Euthymic Patients, with Bipolar Disorder I/II - Utilizing the FAST and FAB tests

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Euthymia, Executive Function,
Frontal Assessment Battery – FAB,
Functioning Assessment Short Test –
FAST, Neuropsychological
Assessment.

Abstract— Objective: In this article, we focus on assessing two key predictors of outcomes in Bipolar Disorder (BD): cognition and functionality performance, and researching for a correlation between them. Methods: Subjects were patients with BD in the euthymic phase ($n=50$), and healthy controls ($n=25$). Psychosocial functioning was evaluated using the Functioning Assessment Short Test (FAST), and the same group underwent the Frontal Assessment Battery (FAB) to assess the Executive Functions (EF). Clinical and sociodemographic characteristics were analyzed using one-way analysis of variance or the chi-square test. To verify a correlation between FAB and FAST tests, we used the Spearman Correlation Coefficient. Results: Patients with BD showed higher FAST total scores (24.60 ± 11.09) than healthy controls (9.80 ± 5.94) ($p < 0.001$), and patients with BD showed lower FAB total scores (13.56 ± 2.81) than healthy control (15.72 ± 1.64) ($p < 0.001$). Associated with these results, bipolar patients showed higher FAST scores in all domains predominantly with moderate impairment (score 21-40), and also lower scores in the following three domains: conceptualization, sensitivity to interference, and inhibitory control in the FAST test ($p < 0.05$). The correlation between the variables FAB and FAST presented a moderate intensity ($r^2 = -0.539$). Conclusion: This study reinforced the impact of BD in functionality and the EF, demonstrating alterations in several domains: social, occupational, and cognitive functions impairment. Understanding them is crucial for these patients, which increases the possibility of rehabilitation and the response to treatment.

I. INTRODUCTION

Bipolar Disorder (BD) is a chronic and severe disease that affects approximately 1.1% of the world population and is associated with a high rate of morbidity, mortality, suicide, and clinical comorbidities [1]. Its pathophysiology is complex, multifactorial, and is not yet fully understood, being influenced by genetic and environmental factors

[2]. Multiple changes occur in the brain, such as neuroplasticity, neurotransmission failures, apoptosis, activation in the immune-inflammatory process, and more recently, oxidative stress [3].

These events involve a pathological reorganization in the brain and therefore are associated with morphological modifications, such as the reduced volume of the

prefrontal cortex, hippocampus, and enlarged amygdala. These structural and biochemical changes are highly recurrent and disabling, developing a process known as neuroprogression. These alterations are possibly secondary to multiple episodes of mania and depression during the disease, raising the hypothesis that bipolar patients may have had changes in their neurocognitive performance with an impact on their daily functionality and psychosocial aspects [4]; [5];[6];[7];[8];[9]. These modifications are usually measurable and characterized by reductions mainly in Executive Functions (EF). The EF is a generic term to describe cognitive processes that allow a person to develop a flexible and independent goal-directed behavior [10];[11]. The EF presents particularly three main domains (working memory, inhibition, and cognitive flexibility), and they are accepted as the basis for other more complex EF, such as; planning, problem-solving, abstract reasoning, among others [12];[13];[14];[15]. Evaluating the specific EF domains, is a time-consuming and difficult task. For this reason, different neuropsychological tests i.e., California Verbal Learning Test; Rey Complex Figure Test; Trail making Test; Verbal Working Memory Test, Wisconsin Card Sorting Test, and more recently FAB Test can be used [16]. An impairment of EF is present in several neurological conditions, such as neurodegenerative disorders, traumatic brain injuries, strokes, and more recently in various psychiatric disorders like substance-use disorders [17];[18], and schizophrenia [19]. Although, the significance of EF deficits is not yet fully understood, many studies have shown that changes in their neurocognitive performance, suggest that they may negatively impact the overall functionality of patients, and be at least partially responsible for the low rate of functional recovery in bipolar patients, even during periods between episodes (euthymia) which were observed in a high proportion of patients [20].

Research has been done in both longitudinal and cross-sectional data about cognitive and psychosocial functioning in BD I/II patients, during different episodes of the disease (mania, depression, and even euthymia), demonstrating that these changes in neurocognition and psychosocial adaptation of these patients compromise their functionality [21];[22];[23];[24];[25];[26];[27];[28]. It was believed that bipolar patients had to reach a euthymic state to recover from the symptoms and their functional capacity, stabilizing the cognitive impairments, and presenting an essential improvement in psychosocial activities. This phenomenon has been questioned recently, and new evidence emerged showing that even in euthymia, some patients had difficulty recovering their premorbid functions after clinical remission, observing a limitation in

occupational activities and psychosocial integration [29];[30]. Thus, remission in BD (euthymia) is not synonymous with patients' recovery and functionality [31]. Gitlin et al. [32] have already described that despite the treatment, 73% of the patients had relapsed with depression and mania many times over a period of five years. Even for those who did not relapse, changes in their psychosocial functioning were observed, especially in the occupational area, generating a poor prognosis for the disease. The hypothesis related to this phenomenon is the cognitive deficits deriving from chronicity of the clinical course, and persistent subsyndromal symptoms [21];[31]. Also, research with patients after the first manic episode, showed that functional impairments were present in up to 70% of patients [33]. Furthermore, occupational impairment was not significantly different in patients during their first episode, than in those with multiple episodes. Even in a prospective observational study including 3681 patients with episodes of acute or mixed mania for two years (2004 to 2006), Goetz et al. [34], found that functional and occupational impairment were already present in the year before their first mania episode. This low functional performance seems to be the norm in patients with BD. However, studies are lacking to establish which clinical variables are associated with cognitive impairment, and what are the impacts of these impairments in BD [35];[36];[37]. Therefore, the objectives of this study are to determine a) if there is any impairment in functionality, and in the frontal neurocognitive functions between a group of BD I/II patients in their euthymic state, when compared to healthy controls, using the FAST and FAB Tests respectively; b) if there are any differences in the demographic, clinical, and pharmacological characteristics in a euthymic population. c) if any cognitive deficits occurred, which deficits were the most frequent in patients with BD during euthymia d) if the cognitive and functional deficits in euthymic patients are correlated with patients younger and older e) if the cognitive and functional deficits in euthymic patients are correlated with the time of study f) to research which category of cut-off scores prevailed in the FAST and the FAB tests among euthymic patients g) to correlate the variables in the FAB and FAST tests, and evaluate if the scores in the FAB (EF) presented an influence on the FAST (functionality).

II. METHOD

2.1 Ethics

This study was approved by the Research Ethics Committee of Universidade da Região de Joinville - UNIVILLE (protocol number 655.037) and followed the

ethical rules of the Helsinki Declaration of 1975. All participants provided written informed consent before entering the study. Each patient underwent a clinical and psychiatric evaluation, where demographic, anthropometric, pharmacological data and clinical variables (age at onset, disease duration, number of episodes, number of hospitalizations, time since last relapse and hospitalization, history of suicide attempts, history of psychosis symptoms, rapid cycling history, and family psychiatric history), were collected.

2.2 Participants

The study evaluated 50 outpatients, with BD types I/II, in the euthymic state, who were recruited from the Porto Seguro Psychiatric Hospital, located in the city of Curitiba, Brazil. All 50 patients were compared against 25 healthy controls. The groups were matched by age, gender, and educational level. The participants were divided into two groups, one group with 50 euthymic BD patients and 25 healthy controls. Most bipolar patients (84%) of this study participated in a psychoeducation program, implemented over the last four years. The psychoeducation program was created to improve the daily capability in patients with BD. During sessions, patients are trained in strategies to be applied in their daily routines, as well as coping with stressful situations that present themselves as triggers for new crises. The treatment of these patients includes pharmacotherapy combined with psychoeducation, and some of them have psychological interventions [38];[39];[40]. The psychiatric diagnosis of BD patients for types I/II was defined in the Manual Diagnosis and Statistics of Mental Disorders (DSM-V), and confirmed by Semi-Structured Clinical Interview, according to DSM-V (SCID-5-CV). Manic and depressive symptoms were assessed using the Young Mania Rating Scale (YMRS) (Young et al. [41] and the 17 items version of the Hamilton Depression Rating Scale (HAMD-17) (Hamilton, [42], respectively. With HAM-17 scale, were evaluated depressive symptoms that had occurred within the last week, and in YMRS, manic symptoms that had presented themselves within the last 48h. The cutoff scores used in the study were: YMRS > 7 as indicative of mania and, HAMD-17 > 8 as indicative of depression. This selection was made to minimize the bias of symptomatology on psychosocial functioning, which has been widely proven in the literature.

2.3 Criteria

The inclusion criteria of bipolar patients in the euthymic stage were: (a) the patients had been in euthymic phase at least six months (b) active age (18 - 60 years); (c) none of the patients had a history of addiction or substance abuse

in last year; (d) no history of neurodegenerative diseases, cancer, morbid obesity or trauma (e) patients had no significant comorbid medical conditions, and did not receive medication in addition to those prescribed for their psychiatric condition; these should have been used for at least four weeks; (f) non-smokers (g) not pregnant or breastfeeding (h) patients were able to understand the procedures and protocol and provided written informed consent, and did not present cognitive impairment with disability or dementia, physical disabilities, e.g., visual or hearing impairing.

Healthy controls were selected among hospital staff, and the subjects were matched for demographic parameters of age, gender, education, and marital status. The inclusion criteria of healthy control patients were: (a) active age (18 – 60 years); (b) no diagnosis of BD confirmed by semi-structured clinical interview (SCID-5-CV) (c) no family history of severe mental illness such as schizophrenia, psychotic disorder, major depressive disorder, and BD in first-degree relatives (d) none of the patients had a history of addiction or substance abuse in the last year; (e) patients had no significant comorbid medical conditions and had not received medication for at least four weeks; (f) no history of neurodegenerative diseases, cancer, morbid obesity or trauma (g) non-smokers (h) not pregnant or breastfeeding (i) patients were able to understand the procedures and protocol and provided written informed consent, and did not present cognitive impairment with disability or dementia, physical disabilities, e.g., visual or hearing impairing.

2.4 Demographic, Clinical and Pharmacological Data

All this data was systematically obtained and included in the study. Demographic variables were age, gender, marital status, education level, employment situation, and years of education. Clinical variables were age at onset, illness duration (years), hospitalization and the duration of hospitalizations, suicide attempts, relatives' antecedents of mental diseases and participation in a psychoeducation group. Also, some psychometric tests were included to observe the following: to assess the manic symptoms we used the Young Mania Rating Scale (YMRS), and to evaluate the depressive symptoms we assessed the 17 items version of the Hamilton Depression Rating Scale (HAMD-17). To obtain information about functional impairment, we used the Functioning Assessment Short Test (FAST), and to assess frontal lobe functions we used Frontal Assessment Battery (FAB).

2.5. Neuropsychological Assessment

2.5.1. Functioning Assessment Short Test (FAST) and Frontal Assessment Battery (FAB)

In recent years, there has been an essential advancement in clinical measurements that analyze the deterioration of superior functions and in the functional impairment. However, these measurements are elaborated, specialized, exhaustive, and expensive. Thus, more straightforward tests like FAB and FAST help to measure cognitive performance and serve as a screen for further evaluation. In this research, we tried to establish the degree of functional impairment through FAST, and the EF through FAB, analyzing a group of BD I/II patients in their euthymic phase, compared with a healthy control group.

2.5.2. Functioning Assessment Short Test (FAST)

FAST is a tool developed to evaluate functional impairment and has been validated in different populations [43];[44];[36];[45]; [46];[47], and ages [48];[49] in BD patients. An analysis of the FAST psychometric properties showed optimal values of inter-observer reliability between two independent evaluations, differing one week from each other (mean $K = 0.73$). The internal consistency obtained was remarkably high, and the Cronbach's alpha was 0.955. There was also a highly significant negative correlation with the Global Assessment of Functioning (GAF) ($r = -0.9$; $p < 0.001$), pointing to a reasonable degree of concurrent validity [50].

The FAST scores are evaluated through six functional domains: **Autonomy** (the capacity to make decisions and do things by oneself); **Occupational Functioning** (the capacity to maintain a paid job, the efficiency of performing tasks at work, working in the field in which the patient was educated and earning according to the level of the employment position); **Cognitive Functioning** (the ability to concentrate, perform simple mental calculations, solve problems, and learn and recall new information); **Financial Issues** (the capacity to manage one's finances); **Interpersonal Relationships** (relations with friends and family, involvement in social activities, sexual relationships and the ability to defend one's interests), and **Leisure Time** (the capacity to engage in sports or physical activities and to enjoy hobbies). Four categories were established in the FAST scale of functional impairment cut-offs. No impairment: from 0 to 11 in the FAST total score. Mild impairment: from 12 to 20 in the FAST total score. Moderate impairment: from 21 to 40 in the FAST total score. Severe impairment: scores above 40 in the FAST total score.). However, patients are not static in a category after an intervention, either pharmacological or psychological, patients can interchange through categories [44];[51].

2.5.3. The Frontal Assessment Battery (FAB)

The Frontal Assessment Battery (FAB) is a brief (10-min) test of EF, consisting of six cognitive tasks that was

developed specifically to assess the frontal lobe functions. An analysis of the FAB psychometric properties showed optimal values of inter-observer reliability ($k = 0.87$; $p < 0.001$), an acceptable internal consistency (Cronbach's alpha = 0.78), and an ability to distinguish between patients and controls of 89% [52];[53]. In our research, we used the Brazilian version of FAB. This battery consists of six subtests which are: **Similarities** (explores the domain of abstract reasoning/conceptualization) i.e., to identify the link between two objects from the same semantic category (an apple and a banana are both fruits). **Lexical Fluency** (letters) (explores the domains of self organized strategy and shifting i.e., mental flexibility) where patients produce as many words as they can, beginning with the letter "S" in one minute. **Motor Series** (explores the domain of motor programming/planning). "Fist-edge-palm" series must be performed six times consecutively and spontaneously with their dominant hand. **Conflicting Instruction** (explores the domain of sensitivity to interference). It provides an opposite response to the examiner's alternating signal, e.g. tapping once when the examiner taps twice and vice versa, the single and double tapings are intermixed in a fixed order. Verbal commands conflict with sensory information and subjects should obey initial verbal command and refrain from following what they see. **Go-No Go Task** (explores the domain of inhibitory control and assesses the ability to withhold a response, inappropriately induced by both previous learning and concomitant sensory information). The same alternating signals used in the previous subtests are again given, but the subjects must now provide different responses, e.g., not tapping when the examiner taps twice and copying the examiner when he taps once. **Prehension Behaviour** (explores the domain of environmental independence). The examiner touches both palms, without saying anything or looking at the subject. If the subject spontaneously takes the hands, it means that sensory stimuli and environmental cues can activate patterns of responses that are normally inhibited [54]. The maximum score for each subtest is three points (with higher scores indicating better performance), and the total score of the test is calculated by adding the scores of the six subtests (maximum score = 18). Any performance score of 18 to 15 indicates a frontal lobe without disabilities. A performance of 14 to 11 is considered a moderate impairment and below 10 is considered a severe impairment. These score cutoffs were validated to a Portuguese population [54].

The FAB test can provide an easier, more reliable, and quicker measure of EF, useful in initial assessments, or when available time and resources are limited. Considering the multifaceted nature of EF, several tools were used to evaluate them, which presented good psychometric

properties, namely good internal consistency, and inter-rater reliability. Tests such as Frontier Executive Screen (FES), Executive Interview-25 (EXIT- 25), and Ineco Frontal Screening (IFS), have shown similar correlation and accuracy in detecting executive deficiencies in various pathologies, just as we observed in the FAB test. However, we know that there is a variability in the different tests concerning the specificity for some of the different EF measured, in different pathologies[55]. Nevertheless, this specificity is still low and has been pointed out as a limitation. Only the FAB and IFS tests presented normative studies, (performance compared to population data matched for age and education). Another issue is the relative usefulness of these executive screening tools in the different stages of neurodegenerative diseases, since the progression generally occurs towards generalized deficits [56]. Thus, the tests above can be useful for the differential diagnosis in the early stages of the disease (when combined with other measures), while their contribution in later stages may be more related to the description of the neurocognitive phenotype.

Although FAB was initially validated in patients with neurodegenerative diseases, and was later extended to other pathologies such as extrapyramidal disorders, vascular damage such as a stroke, dementia such as Alzheimer's disease, and frontotemporal dementia [52];[57];[58];[54];[59]; more recently, different authors have started to research the use of the FAB test for psychiatric diseases [60]; [61]; [62]; [63]; [64]. Regarding psychiatric illnesses, only EXIT-25 and FAB test can evaluate the cognitive tasks and be associated with specific areas of the frontal lobes (that is, able to measure, i.e., conceptualization with the dorsolateral areas, word generation with the medial areas, and inhibitory control with the orbital or medial areas, just as the FAB test was able to exhibit a degree of sensitivity to focal lesions near the anterior insula in the middle right lower frontal gyrus, and in the lower right frontal gyrus), [65];[66], but, it will be discussed forward.

2.6. Statistical analysis

Demographic and clinical variables were analyzed using descriptive statistics, including (mean), and (standard deviation) for quantitative variables and absolute frequency (n), and relatives (%), for qualitative variables with a confidence interval of 95% in both cases. For the qualitative nominal and ordinal data, we used the Chi-square test (χ^2) of Pearson and for two or more groups, we used Fisher's exact test. Parametric and nonparametric tests were used for the analysis of qualitative variables. The assumption of normality and homoscedasticity of each variable was analyzed with the Kolmogorov-Smirnov

normality test and Levene's test, respectively. For comparisons of parametric variables between two groups, the Student *t*-test was used, and more than two groups the Tukey's test of analysis of variance (ANOVA) was used. To compare non-parametric variables between two and three independent samples, the Mann-Whitney tests and the Kruskal-Wallis tests were used, respectively. The Dunn's posthoc test was performed to peer comparisons in case the main effect were significant. For association analyses, Pearson correlation was used to test quantitative variables, and Spearman correlation for nonquantitative variables. In addition, we stratified our sample into five groups according to the level of graduation: illiterate, up to primary school, up to high school, graduate and postgraduate. The total scores of each test; FAST and FAB, were correlated with age and educational level. It is important to note that this battery of evaluation represents only the beginning of cognitive functions, and only specialists who are trained can give a diagnosis, if there are any executive dysfunctions. The most recent version of the SPSS software program (SPSS Inc., Chicago, USA) was used. To calculate the statistical power analyses we used the program - G*Power 3.1. Statistical significance was set at $p < 0.05$ for all tests or adopting a level of significance of 5% to reject the null hypotheses.

III. RESULTS

3.1. Demographic, Clinical and Pharmacological Characteristics

The demographic and clinical characteristics of the different groups studied were evaluated. The sample included 25 healthy controls, and 50 patients with BD. Initially, it was calculated the sample size - difference between two independent means (two tails). The analyses showed an effect size $d = 0.853$; $\alpha = 0.05$; power ($1 - \beta$ err prob) = 0.80; noncentrality parameter $\delta = 2.89$; critical $t = 2.01$; $Df = 44$; sample size group 1 = 23; sample size group 2 = 23; total sample size = 46; actual power = 0.808.

Thirty-six (72%) were female. The healthy control had a mean age of (36.1 ± 9.87) and the euthymic patients analyzed had a mean age of (41.1 ± 11.05) years. Utilizing the *t*-test, the means of healthy controls and euthymic patients did not differ between ages ($t = 2.35$; $F = 1.254$; $p > 0.05$) and utilizing the Chi-square test, there was no difference in gender ($p > 0.05$). There were no significant differences between groups in marital status. However, it was observed after performing the Chi-square test followed by the Fisher's exact test, that the groups significantly differed in terms of their educational level ($p < 0.01$), and occupational status ($p < 0.02$). The mean years of education were (14.7 ± 2.18) years in healthy

controls, and (13.1 ± 2.80) years in euthymic patients. After performing the t-test followed by the Mann Whitney test, the groups significantly differed in terms of years of education ($t=2.52$; $U=418.5$; $p<0.02$). Eight (16%) of patients studied at primary school, 21 (42%) at high school, 21 (42%) had university graduation, and no one with postgraduate education (**Table 1.**)

The bipolar patients had a mean of illness duration of (8.24 ± 7.65) years, and the mean age at onset of illness was (23.1 ± 7.01) years. Seventeen (34%) patients had previously been hospitalized. Among the hospitalized patients, the mean duration of hospitalization was $(13.2 \text{ days} \pm 0.967)$, and eighteen (36%) patients attempted suicide. The family history of BD was positive in 24 (48%) patients. Regarding pharmacologic treatment, our results showed that 10 (20%) of the patients were on monotherapy. Among the patients on polypharmacy, 18

(36%), 16 (32%), and 6 (12%) of the patients received 2, 3, and 4 psychotropic medications, respectively. The percentages of mood stabilizers, antipsychotics, antidepressants, and benzodiazepines used in patients according to their clinical symptoms, are presented in **Table 2.** To evaluate the absence of depression or mania in the samples, the HAM-D and YMRS tests were used in the healthy control group, and in the euthymic patients' group respectively. The observed results had a mean HAM-D score of (4.32 ± 2.40) for healthy control, and (3.88 ± 1.75) for euthymic patients. After performing the t-test, the groups did not differ ($t = 0.88$; $F=2.016$; $p > 0.05$). Regarding a mean YMRS score, the mean was (0.64 ± 0.90) to healthy control and (0.98 ± 1.02) to euthymic patients. After performing the t-test the groups did not differ ($t = 1.41$; $F=1.263$; $p > 0.05$) as seen in the **Table 2.**

Table 1: Sociodemographic Characteristics of the Sample

	Healthy Controls n = 25	Bipolar Patients n = 50	p - Value
Age, years ^b	35.0 (9.96)	41.1 (11.02)	$P = 0,52^c$
Gender, n			$P = 0,43^a$
Male	9	14	
Female	16	36	
Marital status n (%)			$P = 0,55^d$
Married	12 (48.0)	24 (48.0)	
Divorced	1 (4.0)	7 (14.0)	
Widowed	1 (4.0)	1 (2.0)	
Single	11 (44.0)	18 (36.0)	
Education n (%)			$P < 0,01^d$
Illiterate	-	-	
Up to primary school	0 (0.0)	8 (16.0)	
Up to high school	10 (40.0)	21 (42.0)	
Graduate	12 (48.0)	21 (42.0)	
Postgraduate	3 (12.0)	0 (0.0)	
Years of education ^b	14.7 (2.18)	13.1 (2.80)	$p < 0,02^e$
Work situation n (%)			$P < 0,02^d$
Employed	23 (92.0)	30 (60.0)	
Unemployed	2 (8.0)	17 (34.0)	
Medical benefits	0 (0.0)	2 (4.0)	
Invalidity	0 (0.0)	1 (2.0)	

^a χ^2 ^b Mean (SD) ^c t test ^d Fisher's exact test ^e Mann Whitney

Table2: Clinical and Pharmacological Characteristics of the Sample

	Healthy Controls n = 25	Bipolar patients n = 50	p- Value
Illness duration (years) ^a	N/A	8.24 (7.65)	
Age of onset (years) ^a	N/A	23.1 (7.01)	
HAM-D total score ^a	4.32 (2.49)	3.88 (1.75)	$p = 0.50$ ^b
YMRS total score ^a	0.56 (0.86)	0.98 (1.02)	$p = 0.08$ ^b
FAST score ^a	9.80 (5.94)	25.10 (11.08)	$p < 0.001$ ^c
FAB score ^a	15.72 (1.64)	13.56 (2.81)	$p < 0.001$ ^c
Hospitalizations n (%)	N/A	17 (34)	
Duration hospitalizations (day) ^a	N/A	13.20 (30.7)	
Suicide attempts n (%)	N/A	18 (36)	
Family history of affective disorders n (%)	N/A	24 (48)	
Psychoeducation Yes, n (%)	N/A	42 (84)	
Treatment n (%)			
Lithium	N/A	29 (58)	
Other mood stabilizers	N/A	22 (44)	
Atypical antipsychotics	N/A	19 (38)	
Typical antipsychotics	N/A	4 (8)	
Antidepressants	N/A	14 (28)	
Benzodiazepines	N/A	11 (22)	

HAM-D 17 = Hamilton Depression Rating Scale; YMRS = Young Mania Rating Scale; N/A = not available

^a Mean (SD) ^b *t* test ^c Mann Whitney

3.2. Functional Status and Neurocognitive Performance.

3.2.1. Healthy Controls versus Euthymic Patients

The results of the general functional and cognitive assessments were measured by performing the FAST and FAB tests (mean \pm SD) for healthy control and euthymic patients, respectively. The means of the FAST test were (9.80 \pm 5.94) and (24.6 \pm 11.15), respectively; and it was observed after performing the *t* test followed by the Mann Whitney test ($t = 6.195$; $U = 126$; $p < 0.001$). The means of the FAB test were (15.72 \pm 1.64) and (13.68 \pm 2.61), respectively and the results were observed after performing the *t* test followed by the Mann Whitney test (t

$= 3.567$; $U = 310$; $p < 0.001$). Through the FAST and FAB tests, we concluded that the patients with BD had greater functional and cognitive impairment than healthy controls, as seen in the **Table 2 and Figs.1-2**. Our results are compatible with other research performed [44];[50];[45];[67].

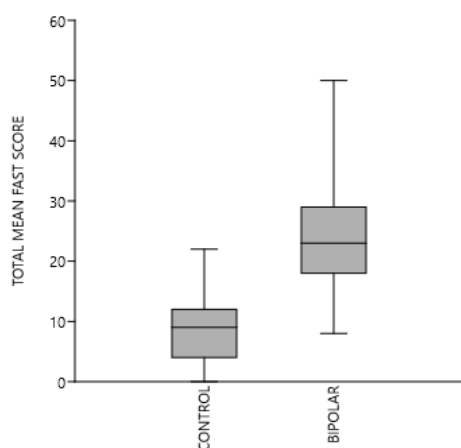


Fig.1. Mean (SD) Total Functioning Assessment Short Test (FAST) Scores between Healthy Control and Patients

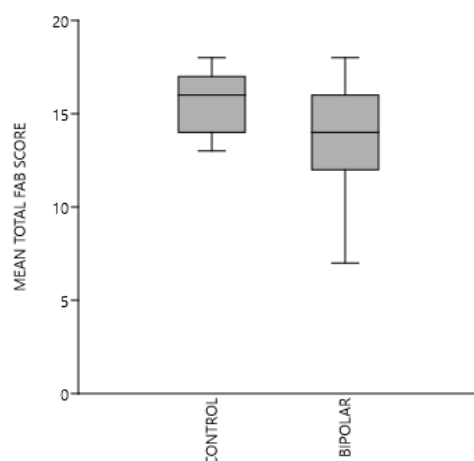


Fig.2. Mean (SD) Total Functioning Assessment Short Test (FAB) Scores between Healthy Control and Patients.

Table 3: Mean Total of FAST and FAB Scores in Health Controls and Euthymic Patients with ≤ 40.5 and ≥ 40.5 years old

	Healthy Control <i>n</i> =25	Euthymic Patients <i>n</i> = 50 <i>n</i> =25 each group	<i>t</i>	<i>U</i>	<i>p</i>	<i>d</i>	<i>r</i>
1. Means (\pm SD)FAST < 40.5 y	9.27 (\pm 4.84)	23.9 (\pm 10.01)	6.035	39.0	< 0.001**	-1.860	-0.681
2. Means (\pm SD)FAST > 40.5 y	11.14 (\pm 8.47)	24.9 (11.51)	2.622	30.5	< 0.001**	-1.361	-0.562

3.2.2. FAST and FAB score and age

Based on these results, our group decided to divide the samples into two groups by age. For this purpose, we used the median age of the patients (median = 40.5 years). Twenty-five patients were younger than 40.5 years old, and 25 patients were older than 40.5 years old. We used the same method with the control group, and the following results were observed. The results of the FAST and FAB tests were demonstrated (mean \pm SD) to each median (\leq and \geq 40.5 years old), for control and euthymic patients groups, respectively.

The (means \pm SD) of FAST scores between the healthy control group and the euthymic group in a median ≤ 40.5 and ≥ 40.5 years old were (9.27 \pm 4.84), (23.9 \pm 10.01) and (11.14 \pm 8.47), (24.9 \pm 11.51) respectively. After performing the *t*-test followed by the Mann Whitney test, the groups differed in age (*t* = 6.035; *U* = 39.0; *p* < **0.001**) and (*t* = 2.622; *U* = 30.5; *p* < **0.001**), respectively. The (means \pm SD) of FAB scores between the healthy control group and the euthymic group in a median ≤ 40.5 and ≥ 40.5 years old were (15.72 \pm 1.63), (14.0 \pm 2.99) and (15.71 \pm 1.79), (13.2 \pm 2.62), respectively. After performing the *t*-test followed by the Mann Whitney test, the groups differed in age (*t* = 2.261; *U* = 139.5; *p* < **0.01**) and (*t* = 2.406; *U* = 36.5; *p* < **0.001**), respectively, as seen in the Table 3.

3. Means (\pm SD) FAB < 40.5 y	15.72 (\pm 1.63)	14.0 (\pm 2.99)	2.261	139.5	< 0.01**	0.714	0.336
4. Means (\pm SD) FAB \geq 40.5 y	15.71 (\pm 1.79)	13.2 (\pm 2.62)	2.406	36.5	< 0.001**	1.118	0.488
FAST total score	9.80 (\pm 5.94)	24.60 (\pm 11.09)	6.34	3.24	0.001	-1.663	-0.693
FAB total score	15.72 (\pm 1.64)	13.56 (\pm 2.81)	3.56	2.50	0.001	0.938	0.424

Note. Means \pm standard deviation (SD). FAB = Frontal Assessment Battery FAST = Functioning Assessment Short Test.[*] indicate FAB and FAST scores significantly different between groups by t-test (*t*)and followed by Mann–Whitney test (*U*) for independent samples, *d* = Cohen’s effect size. *****p* < 0.01**

However, when comparing the FAST group and FAB group with age between (≤ 40.5 and ≥ 40.5 years old) we did not observe any significant difference, as shown in **Figs.3-4**. The means of the age of the FAST groups with median ≤ 40.5 and ≥ 40.5 years old, were (23.9 ± 10.06), and (24.9 ± 11.51), respectively. After performing the *t*-test followed by the Mann Whitney test, the groups did not differ in age (*t*=0.340; *U*= 295.5; *p* > **0.05**). The means of the age of the FAB groups were (13.9 ± 2.98), and (13.1 ± 2.62), respectively. After performing the *t*-test followed by the Mann Whitney test, the groups did not differ in age (*t*=0.955; *U*= 268.5; *p* > **0.05**), as seen in **Figs.3-4**.

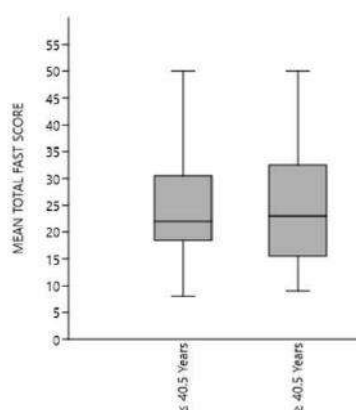


Fig.3. Mean Total of FAST Scores in Euthymic Patients with ≤ 40.5 and ≥ 40.5 years old

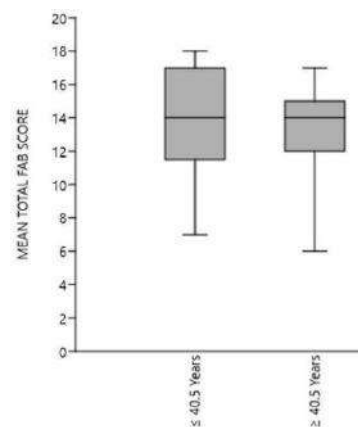


Fig.4. Mean Total of FAB Scores in Euthymic Patients with Median ≤ 40.5 and ≥ 40.5 years old

Thus, it was observed that the euthymic patients had greater functional (FAST) and frontal cognitive (FAST) impairment than healthy controls, in both groups (≤ 40.5 and ≥ 40.5 years old). Nevertheless, when we compared the groups FAST (≤ 40.5 and ≥ 40.5 years old) and FAB

(≤ 40.5 and ≥ 40.5 years old) we did not observe any significant difference between them. Thus, in this study, it showed that to be younger or older (age ≤ 40.5 years and ≥ 40.5 years), did not differ from the total scores of the FAST and FAB tests.

3.2.3. FAST and FAB score and years of study

In addition to age, another point that was assessed by our study and which may interfere in the FAST and FAB results, is the number of years spent studying. Various authors observed that the study time could influence the test results [70];[68];[69]. Our samples (healthy control and euthymic patients) presented a study time variation between (8 to 18 years). Based on these values, our group decided to divide the samples into two groups. For this purpose, we used the median of study time (median = 12 years) (≤ 12 years of study and > 12 years of study). Twenty-seven euthymic patients studied ≤ 12 years and 23 euthymic patients studied > 12 years. We used the same method with the control group, and the following results were observed. The results of the FAST and FAB tests were demonstrated (mean \pm SD) to each median (≤ 12 and > 12 years), for control and euthymic patients groups, respectively. As previously described above, see **Table 1**, after performing the t -test followed by the Mann Whitney test, the groups in study time differed significantly between healthy control (14.7 ± 2.18) and euthymic patients (13.1 ± 2.80); ($t = 2.52$; $U = 418.5$; $p < 0.02$).

However, the (means \pm SD) of FAST scores between the healthy control group and the euthymic patients' group in a median ≤ 12 years were (11.7 ± 7.76) and (27.4 ± 12.72) respectively. After performing the t -test the groups differed in study time ($t = 3.10$; $F = 2.687$; $p < 0.003$). The means of FAB scores between the healthy control group and the euthymic patients' group in a median ≤ 12 years were (15.8 ± 1.06) and (13.5 ± 2.77) respectively. After performing the t -test the groups differed in study time ($t = 2.16$; $F = 6.755$; $p < 0.03$). The (means \pm SD) of FAST scores between the healthy control group and the euthymic patients' group in a median > 12 years were (9.1 ± 5.15) and (21.3 ± 8.01) respectively. After performing the t -test the groups differed in study time ($t = 5.61$; $F = 2.42$; $p < 0.001$). The (means \pm SD) of FAB scores between the healthy control group and the euthymic patients' group in a median > 12 years were (15.8 ± 1.73) and (13.4 ± 2.98) respectively. After performing the t -test the groups differed in study time ($t = 52.97$; $F = 2.995$; $p < 0.01$), see **Table 4 – 5**.

Table 4: Mean Total of FAST and FAB Scores in Healthy control and

Euthymic Patients with Median ≤ 12 years of study

	Healthy Control (MEANS \pm SD)	Euthymic Patients (MEANS \pm SD)	t	F	p
FAS T	11.7 \pm 7.76	27.4 \pm 12.72	3.103	2.687	< 0.003**
FAB	15.8 \pm 1.06	13.5 \pm 2.77	2.16	6.755	< 0.03*

Table 5: Mean Total of FAST and FAB Scores in Healthy control and Euthymic Patients with Median > 12 years of study

	Healthy Control (MEANS \pm SD)	Euthymic Patients (MEANS \pm SD)	t	F	p
FAS T	9.1 \pm 5.15	21.3 \pm 8.01	5.61 1	2.42 0	< 0.001**
FAB	15.8 \pm 1.73	13.4 \pm 2.98	2.97	2.99 5	< 0.01*

However, when compared the FAST groups (≤ 12 years and > 12 years), and FAB groups (≤ 12 years and > 12 years), we did not observe any significant difference as shown in **Figs.5-6**. The means of the years of study of the FAST groups with median ≤ 12 and > 12 years of study, were (27.4 ± 21.2), and (21.2 ± 8.01) respectively. After performing the t -test, the groups did not differ in time of study ($t = 1.901$; $F = 2.865$; $p > 0.05$). The means of the years' study of the FAB groups with median ≤ 12 and > 12 years, (13.5 ± 2.77), and (13.4 ± 2.98) respectively. After performing the t -test followed by the Mann Whitney test, the groups did not differ in time of study ($t = 0.049$; $F = 1.152$; $p > 0.05$) see **Figs.5-6**.

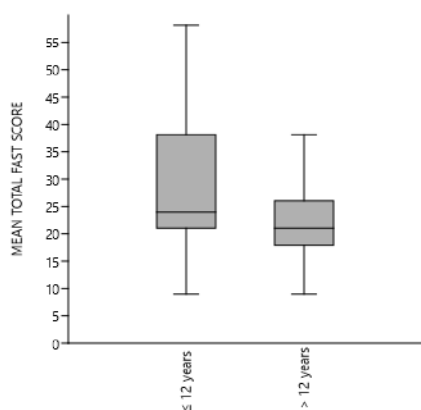


Fig.5. Mean Total of FAST and FAB Scores in Healthy control and Euthymic Patients with Median ≤ 12 years of study

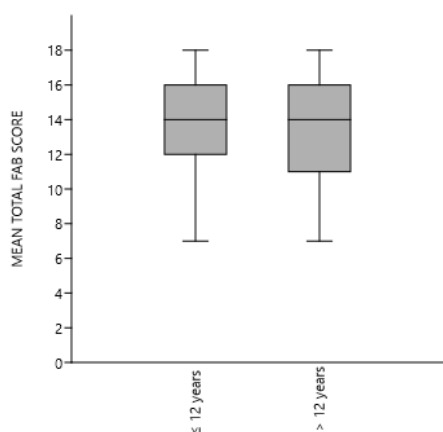


Fig.6. Mean Total of FAST and FAB Scores in Healthy control and Euthymic Patients with Median > 12 years of study

Thus, in this study, it demonstrated that years of study showed that less (≤ 12 years of study) or more (> 12 years of study), did not differ from the total scores of the FAST and FAB tests.

3.2.4. Categories Scores of FAST and FAB tests in Healthy Controls and Euthymic patients

As mentioned above, FAST and FAB tests have different scoring categories. These different categories demonstrate a greater or lesser severity in the patient's functionality in their daily life (FAST) and impairment or not in his frontal cognitive activity. The **Table 6**, demonstrates that 88% ($n = 44$) of the patients had overall functional impairment (defined as a FAST total score > 11) compared to 28 % ($n = 9$) of the control group ($p < 0.001$). There was a predominance of the first category in the total FAST scale (0 to 11 - no impairment) ($n = 18$; 72%), in the control group. However, in the bipolar patients, there was a predominance of the third category in the total FAST scale (21 to 40 - moderate impairment) ($n = 30$; 60%). For the analysis of nominal and ordinal qualitative data, Pearson's chi-square test (χ^2) was used for two or more groups. The results showed that there was a significant difference in the four categories between the control group and the bipolar patients, in the FAST test ($p < 0.001$). On the other hand, **Table 7**, demonstrates that there was a predominance of the first category in the total FAB scale (18 to 15 - no impairment) ($n = 18$; 72%), in the control group. However, in the bipolar patients, there was a predominance of the second category in the total FAB scale (14 to 11 - moderate impairment) ($n = 26$; 52%). For the analysis of nominal and ordinal qualitative data, Pearson's and chi-square test (χ^2) were used for two or more groups. The results showed that there was a significant difference in the three categories between the control group and the bipolar patients, in the FAB test ($p < 0.001$). Thus, both, the FAST and the FAB groups showed a moderate impairment in functionality and EF.

Table 6: FAST total scale and the categories of functional impairment cut-offs

	Healthy Control N = 25	Bipolar patients N = 50	p - Value
FAST score			$p < 0.001^a$
0 - 11 No impairment	18	6	
12 - 20 Mild impairment	5	9	
21 - 40 Moderate impairment	2	30	
41 - 60 Severe	0	5	

impairment**(FAST)Functioning Assessment Short Test** ^a χ^2 followed by Fisher's exact test

Table 7: FAB total scale and the categories of cognitive impairment cut-offs

	Healthy Control N = 25	Bipolar patients N = 50	p - Value
FAB score			p < 0.01 ^a
18 - 15 No impairment	18	18	
14 - 11 Moderate impairment	7	26	
10 - 0 Severe impairment	0	6	

(FAB)Frontal Assessment Battery ^a χ^2 followed by Fisher's exact test

3.2.5. Categories Scores of FAST test in Healthy Controls and Euthymic patients

Significant differences were found in all distinct domains of the FAST test between euthymic patients and healthy controls, ($p < 0.05$), as seen in the **Fig.7**. Specifically, patients showed decreased in occupational, autonomy, cognitive and interpersonal domains, had the most significant differences ($p < 0.001$), suggesting that these domains may be the most impaired. All effect sizes (d) were in the same direction, suggesting worse performance in the patient group than in the healthy control, see **Table8**.

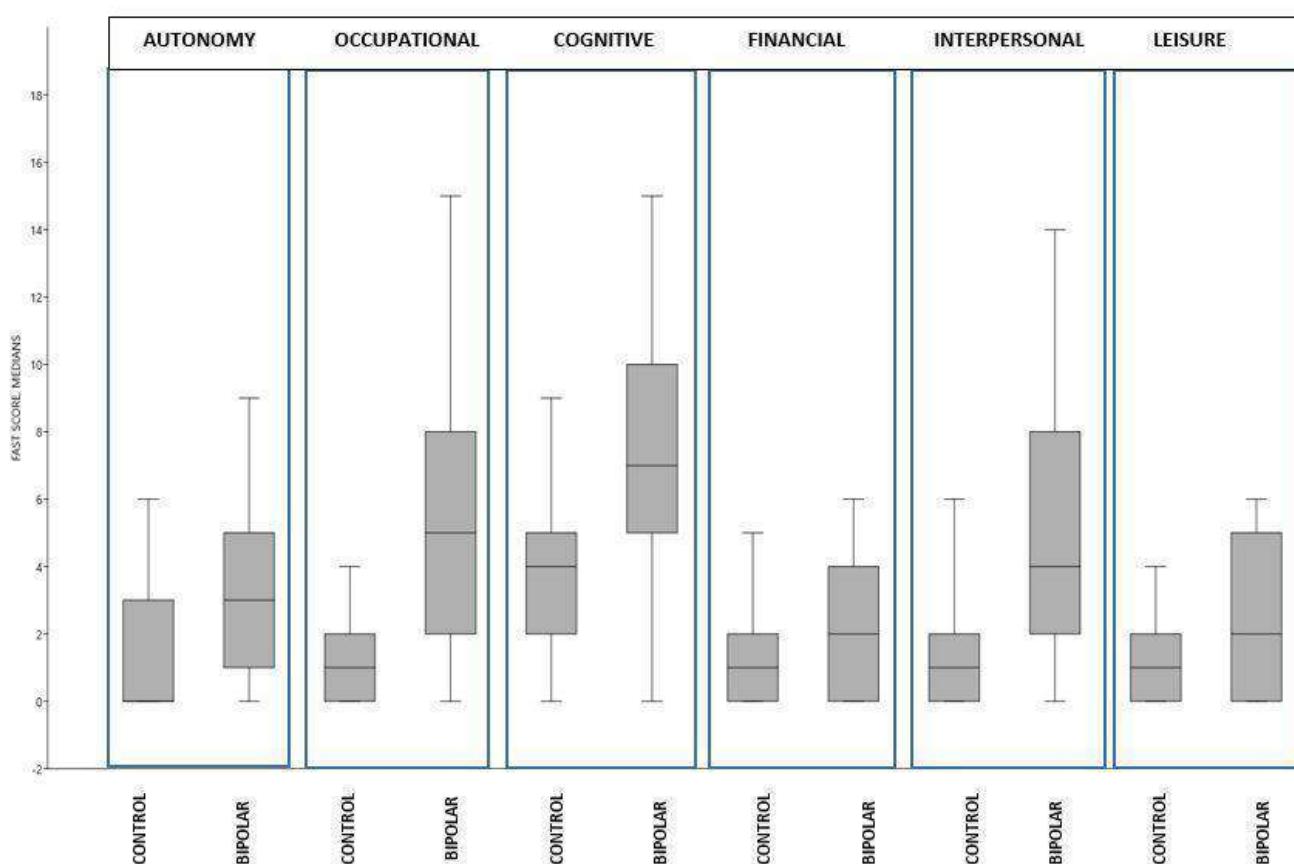


Fig.7. Mean Functioning Assessment Short Test (FAST) Domain Scores and Healthy Controls

Table8: Neurocognitive functioning as assessed by the FAST in Bipolar Patients

<i>FAST Subtest</i>	CONTROL GROUP n=25	BIPOLAR GROUP n= 50	<i>t</i>	<i>F</i>	<i>p</i>	<i>d</i>	<i>r</i>
<i>1. Autonomy</i>	1.20 (±1.76)	3.24 (±2.61)	3.52	2.20	0.001*	-0.916	-0.416
<i>2. Occupational Functioning</i>	0.96 (±1.10)	5.32 (±4.24)	5.03	14.93	0.001**	-1.407	-0.575
<i>3. Cognitive Functioning</i>	4.00 (±2.25)	7.50 (3.66)	4.37	2.63	0.001**	-1.152	-0.499
<i>4. Financial Issues</i>	1.32 (±1.49)	2.32 (±2.01)	2.19	1.82	0.04*	-0.565	-0.271
<i>5. Interpersonal Relationship</i>	1.24 (±1.56)	5.12 (±4.10)	4.55	6.90	0.001**	-1.250	-0.530
<i>6. Leisure Time</i>	1.20 (±1.22)	2.62 (±2.23)	2.96	3.31	0.01*	-0.790	-0.367
<i>FAST total score</i>	9.80 (±5.94)	24.60 (±11.09)	6.34	3.24	0.001**	-1.663	-0.693

Note. Means ± Standard Deviation (SD). FAST = Functioning Assessment Short Test. Analysis of FAST subtests scores by t-test (*t*) (*F*) for independent samples, *d* = Cohen's effect size. **p* < 0.01 and ***p* < 0.001.

3.2.6. Categories Scores of FAB test in Healthy Controls and Euthymic patients

In the original FAB test, Dubois et al. [52] produced a theoretical construct, suggesting a two-factor structure of the FAB test. The two-factor are composed of cognitive and behavioral aspects. The first factor is assigned as a **cognitive control factor**, which includes the **Conceptualization; Mental Flexibility, and Inhibitory Control** subtests. These three subtests primarily examine abilities related to performing mental operations (such as verbal abstraction and inhibition of inappropriate responses). The second factor is assigned as a **behavioral control factor**, which includes **Motor programming, Sensitivity to interference, and Environmental autonomy** subtests. These three subtests mainly evaluate the abilities of motor regulation, such as

motor sequencing and withholding of automatic movements. In the present study, our results, in addition to reinforcing this construct, can observe that two subtests that characterize the cognitive control factor (**Conceptualization and Inhibitory Control**) showed significant changes (*p* < 0.05). All effect sizes (*d*) were in the same direction, suggesting worse performance in the patient group than in the healthy control. Nevertheless, only one subtest related to behavioral control factor (**Sensitivity to interference**) showed a significant difference between groups (*p* < 0.01) as we can see in **Table 9**. Thus, in this study, we observed that the impact of the BD, even in patients in the euthymic phase becomes present in factors related to cognition and motor factors [71], as seen in the **Table9**.

Table 9: Neurocognitive functioning as assessed by the FAB in Bipolar Patients

<i>FAB Subtest</i>	CONTROL GROUP n=25	EUTHYMIC GROUP n= 50	<i>t</i>	<i>F</i>	<i>p</i>	<i>d</i>	<i>r</i>
1. Similarities (Conceptualization)	1.84 (±0.85)	1.34 (±1.08)	2.01	1.61	0.041*	0.514	0.249
2. Lexical Fluency (Mental flexibility)	2.72 (±0.46)	2.50 (±0.61)	1.58	1.79	0.147	0.407	0.197
3. Motor Series (Motor programming)	2.92 (±0.28)	2.64 (±0.72)	1.86	6.79	0.064	0.512	0.248
4. Conflicting Instruction (Sensitivity to interference)	2.92 (±0.54)	2.52 (±0.76)	2.53	7.58	0.013*	0.606	0.290
5. Go-No Go Task (Inhibitory control)	2.32 (±1.14)	1.50 (±1.46)	2.45	1.62	0.026*	0.626	0.298
6. Prehension Behaviour (Environmental autonomy)	3.00 (±0.00)	2.94 (±0.42)	0	0	0.498	0.202	0.100
FAB total score	15.72 (±1.64)	13.56 (±2.81)	3.56	2.50	0.001	0.938	0.424

Note. Means ± Standard Deviation (SD). FAB = Frontal Assessment Battery. Analysis of FAB subtests scores by t-test (*t*) (*F*) for independent samples, *d* = Cohen's effect size. **p* < 0.05.

3.3. Correlation between FAST and FAB tests scores in euthymic patients

The **Fig.8** displays the impact of cognitive function (FAB test) of euthymic patients on functionality (FAST test). The correlation between frontal cognition and functionality was analyzed through the scores of the FAB and the FAST tests in euthymic and healthy control patients, using the Spearman Correlation Coefficient. Although only a small number of samples of euthymic patients were used (n=50) and healthy control (n=25), it was possible to observe a negative Spearman Correlation Coefficient, after assessing normality using the Shapiro-Wilk test. The correlation presented a moderate intensity ($r^2 = -0.539$) to euthymic patients and very weak correlation in healthy control ($r^2 = -0.106$). This correlation between the variables FAB and FAST, demonstrated that euthymic patients who have

lower scores on the FAB (decreased frontal activities and EF), had higher scores on the FAST (with greater loss of functionality). Since $r^2 = -0.539$, it represent a moderate correlation, and the FAB variable alone is not able to explain the total FAST variability. However, the sample results provide significant statistical evidence between FAB and FAST ($p < 0.0001$). Regarding the healthy control group, we did not find a significant correlation, ($p > 0.05$). Furthermore, it is important to remember that the correlation coefficient (r^2) is only an estimate of the population correlation coefficient (*p*), and we should not forget that the value of *r* is calculated based on some data pairs constituting random samples. Often the points in the sample may show a correlation, and even though the population does not, in this case, we are facing an inference problem, since $r \neq 0$ is not a guarantee that $p \neq 0$.

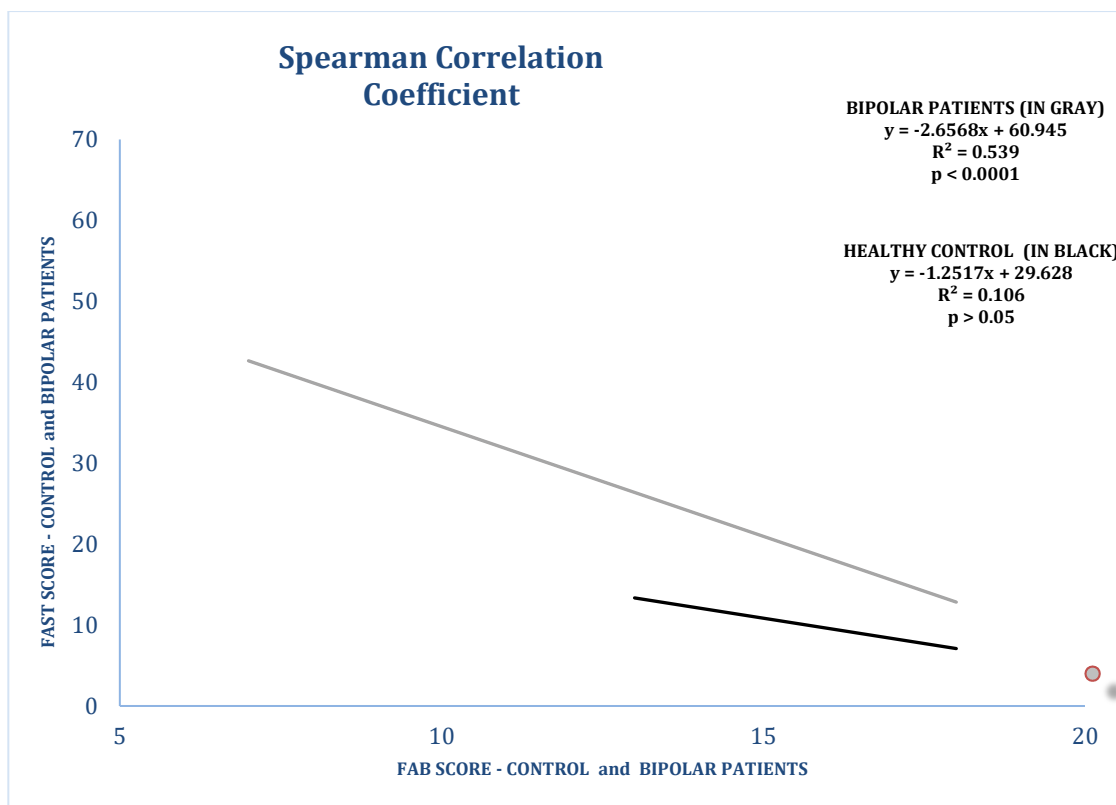


Fig. 8 .Correlation between FAST and FAB test scores in healthy control (n= 25) (in black) and euthymic patients (n=50) (in gray), using the Spearman Correlation Coefficient.

3.3.1. Correlation between years of education with FAST and FAB tests scores in euthymic patients

We analyze through a correlation test, the control group which presents a (mean \pm SD) years of education (14.72 ± 2.18) correlating with a mean total of FAST score (9.80 ± 5.94), and a mean total of FAB score (15.72 ± 1.64). We used the Spearman correlation coefficient test, and no significant correlation was found (FAST $r^2 = -0.21$ and FAB $r^2 = 0.06$, $p > 0.05$). Posteriorly, we evaluated 50 euthymic patients, which presents a mean years of education (13.1 ± 2.84 years, ranging between 8 to 19 years), correlating with the mean total FAST score (24.6 ± 11.15 , ranging between 8 to 58 score) and a mean FAB score (13.68 ± 2.61 score, ranging between 6 to 18 score). After the Spearman correlation coefficient test, no significant correlation was found related to the FAST scores and years of education ($r^2 = -0.018$; $p > 0.05$). However, we found a positive correlation between the years of education and FAB scores, ($r^2 = 0.326$; $p < 0.05$) by utilizing the Spearman coefficient test, see Figs.9-10.

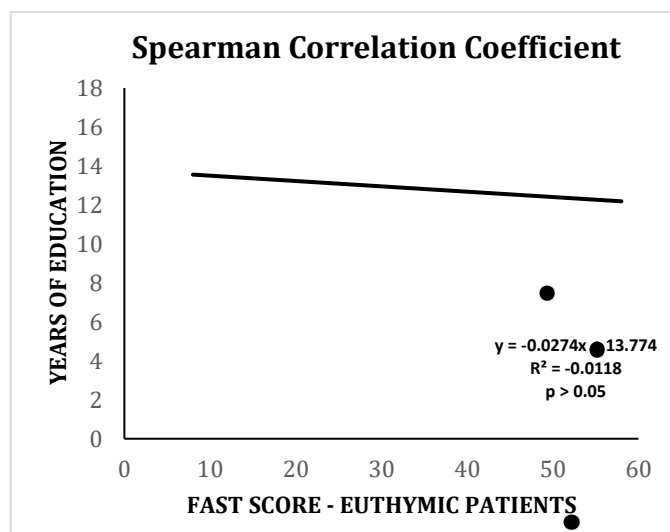


Fig.9. Correlation between years of education and FAST score of euthymic patients Linear regression $p > 0.05$; $r^2 = -0.011$.

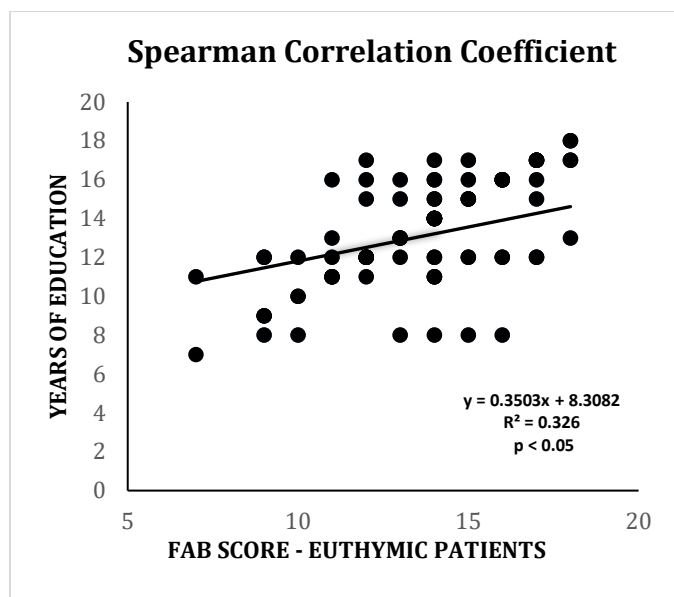


Fig.10. Correlation between years of education and FAB score of euthymic patients Linear regression $p < 0.05$; $r^2 = 0.326$.

IV. DISCUSSION

Since the beginning of this research, we have tried to apply standardized criteria for euthymia and the control group strictly. We wanted to reduce the biases related to this research, as much as possible. The safety measurements, criteria, and diagnosis of the disease, as well as the sample of bipolar patients who had been in the euthymic phase for at least six months, resulted in more accurate data. The rigor in the application of all the tests used by our highly trained staff eliminated any dubious interpretation or results of FAST and FAB. In a meta-analysis, [72], showed that many previous studies had not expressed this concern with standardization, producing a considerable variability in the results found [73]. Despite the meticulous application of the tests by the staff; some biases were still present, e.g., the small number of patients in each group, the heterogeneity of the population as well as their educational level, the diversity of medications used by patients, which may produce different effects on cognition. Another relevant point which was considered when analyzing the bipolar patients' cognitive abilities, was their age. Numerous age-related changes in cognitive abilities are significant to the everyday activities of the patients. According to [74], studies of the neurophysiological processes on cognitive performance have shown that cognitive skills reach their maximum point at the age of 30 and remain stable until they start to decline to 50 to 60 years old. Many studies demonstrated lower cognitive levels during aging [75]; [76]; [77]; [78]; [79]. This physiological decline

in senescence is due to neuro-anatomical changes that cause a degradation of the brain structure; however, this decline in cognitive functions is not uniform for all of them. Functions such as the ability to communicate through language, the use and definition of words; evocation and knowledge of general culture; practical or social reasoning; remain stable during their lives. However, they have difficulties in understanding long and complicated phrases, quickly recalling specific names or terms, sometimes generating a more repetitive speech; difficulty in understanding organized and logical analysis of unfamiliar or abstract material. Performance in the planning, execution, and evaluation of complex scales of behavior and performance of new and fast perceptual motor tasks, is also impaired [74]; [80]; [75]; [81]; [82]. For this reason, we only included patients with a maximum age of 60 years old, trying to reduce any bias related to the cognitive test results, both in the natural and pathological aging process.

Through this strict criteria adopted for the inclusion of bipolar patients in our study, we observed statistically significant results after applying the FAST and FAB tests that occurred both in the means (Figs.1-2), as well as in the different domains of the tests (Fig.7; Tables 8-9). In the FAST test, we analyzed an important decrease in the functional capacity of bipolar patients in all domains, which made us realize the impact of the disease on the patients' daily lives. These results are clearly related to previous literature studies, where several authors observed the same results [24]; [83]; [84]; [85]; [67]. Also, Bonnin et al. [25], assessed a total of 32 euthymic bipolar patients clinically and neuropsychologically at baseline. After an average 4-year follow-up, they were interviewed with the FAST test to assess functional outcomes. They observed that depressive symptomatology together with neurocognitive impairments related to verbal memory and EF are predictor variables of long-term functional outcome in BD. In a recent categorical meta-analysis which included 11 other studies, with a total sample of 1083 patients, the prevalence of global functional impairment was 58.6%. Regarding the specific domains, the meta-analysis presented an impairment prevalence in the following domains: 65.6% in the occupational, 49.2% in the cognitive, 42.6% in the autonomy, 42.1% in the interpersonal relationships, 29.2% in the leisure, and 28.8% in the financial issues domain - all of which were statistically significant [86]. In another study on the relationship between cognitive and occupational function in euthymic patients, it was reported that over six months, cognitive measures at the time of symptomatic recovery, particularly in the domains of working memory/attention and speed of processing, were strongly associated with

concurrent occupational recovery[87]. These findings suggest that a decline in cognitive function over time can be paralleled by a functional decline in occupation despite an euthymic state in bipolar disorder. We found very similar results in our research, which are presented in **Fig.7**, and they reinforce the idea that BD has a significant impact on the day to day functionality in these patients' lives.

Regarding the FAB test, and confirming one of our initial hypotheses, we observed the same phenomenon. The FAB test performance in our study presented significantly worse scores in the following domains: similarities (conceptualization), conflicting instructions (sensitive to interference), and go/no-go (inhibitory control), which demonstrated a significant executive dysfunction in bipolar patients (**Table 9**). However, since few studies up to date used the FAB test for patients with BD, we found it difficult to correlate our results with previous studies. For this purpose, we compared the results found in other studies, researching different psychiatric pathologies with altered EF, which also observed similar results [17];[18];[19]. Furthermore, our results differed from other studies that also evaluated the components of EF in euthymic patients with BD, and who performed poorly in mental flexibility, unlike our study [88];[89];[90]. Other domains such as inhibitory control [91], and conceptualization [29];[90], remained preserved in these studies, nevertheless were different from our results. Even so, our results are in line with previous studies demonstrating a substantial proportion of bipolar patients who experienced unfavorable general functioning, and that there is a significant degree of morbidity and dysfunction associated with BD, even during euthymic periods [37];[92].

Data from two meta-analyses demonstrated that cognitive changes persist during euthymia; even though there is a variation in the results concerning the domains involved, and the effect size produced [93];[16]. There are many discrepancies between authors regarding the performance in many different neuropsychological tests related to EF by bipolar patients. For example, patients in the manic phase may have difficulty adapting to conceptual changes, as can be seen in the Trail Making Test, as well as, during the depressive phases, demonstrating that bipolar patients have a poorer performance especially in verbal fluency tests, when compared with unipolar patients. Also, in the euthymic phase, changes in EF were observed with several persevering errors in the Wisconsin Card Sorting Test. Thus, using different tests, to assess the EF, it was observed that the degree of commitment and the size of the effect can be quite diverse between the various domains. In summary, different EF were not equally impaired in

euthymic BD patients [94];[95];[96]. It became significant in our research because we tried to evaluate the possible confounding variables that could interfere with the result found in the correlation between the FAB and FAST tests. A characteristic of the confounding variable is that it influences both the dependent and the independent variables, which can cause a spurious association. In our study, clinical variables such as (gender, age, length of illness), showed little effect on executive performance, except the study time, which showed some correlation with the FAB test as seen in the **Fig.10**, which will be discussed next. As previously described, this research showed particularly that less or more years of studying (≤ 12 years and > 12 years), did not differ from the total scores of the FAST and FAB tests. However, our study did not take into account some significant variables, as described by Shoeyen et al. [97], that observed that the main clinical variables that were significantly associated with lower levels of education in euthymic patients were associated with: the age of the first episode, the number of rapid cycling, and who had more than four depressive episodes. In our research, we found that the (mean \pm SD) of years of schooling completed was (14.7 ± 2.18) years for the healthy control group, and (13.1 ± 2.80) years for euthymic patients which were very significant difference ($p < 0.01$), see **Table 1**. Furthermore, the level of education was different between groups. While the control group had the majority of subjects (60%) with graduate and postgraduate education, the euthymic patients had (84%) up to high school and graduated with a significant difference ($p < 0.02$). Our findings were following a nationwide Danish register study [98], reporting lower educational levels in BD compared to the general population. In a survey that compared bipolar patients to healthy control, where IQ levels similar, it was observed that patients with BD completed fewer years of education than controls. Although more than 60% of both groups entered college, only 16% of bipolar patients received a university degree. In contrast, 47% of control patients completed college. Although the educational level did not differ between patients who started the disease earlier or later, nor due to substance abuse [99]. Another research demonstrated, that more education and shorter illness duration remained significantly associated with functional recovery. One more year of education was associated with a 1.45 times higher chance of functional recovery, and being ill one year longer was associated with a lower chance of functional recovery [100]. More recently, Baune and Malhi, [101], observed a slightly different result, where patients with BD had the same level of education, however, had a significantly lower social and occupational function than the general population.

Curiously, in our research we also observed a shorter time concerning the years of education in the bipolar patients, which produced a greater impact on occupational activities; as seen in the **Table 1**. Thus, the level of education is interrupted due to crises during BD, and the reduction in the level of education may contribute to the later functional disability in this disease. Thus, many studies showed that there is an inverse correlation between the degree of education with the social, occupational function, and risk of disability[102];[103];[104]. Also, other studies had shown that bipolar patients' household income was below 10%, and many of them were on disability pension in comparison with the general population, [105];[106];[98]. Thus, our results are according to literature reinforcing the previous studies.

Another variable related to cognitive functions and the functionality is age. It was interesting to note that our study was not associated with the loss of functionality and cognitive functions with the age of the patients, as can be seen in **Table 3; Figs.**

3-4. We found very significant differences between both the control group and euthymic patients after using the FAB and FAST tests. However, when comparing the younger euthymic patients with the older ones, we did not observe any important differences, which supports our hypothesis that it might not be the age of the subjects studied that will determine the effect on the FAB or FAST tests, but most probably the time of the disease. We know that many of the youngest patients (≤ 40.5 years old) in our euthymic group have had the pathology for more than 10 to 15 years, while many older patients (≥ 40.5 years old) had recently started the disease; less than two or three years ago. After this discovery, we started planning a new study with a division of two groups of euthymic patients with early (less than 2 years) and late (more than 10 years) diagnoses of the disease, and we will reapply the above tests. We also intend to better clarify the issue of the impact of the number of crises of depression and mania on the evolution of the disease by collecting more data, even though it was not our initial intention. Thus, our partial results are supported by many authors in the literature that showed cognitive deficits, including EF, memory, and attention, and do not seem to be strictly a later effect of years of illness, because young people who had a recent manifestation of BD, had cognitive deficits that resemble that of adult patients, and these deficits can be observed even during euthymia [107];[78]; [108];[109]. Recently, in important research, [110] evaluated a sample of 51 euthymic bipolar patients, who were followed up for a mean period of 73 months. They suggested that a longitudinal trajectory of cognitive deficits in BD is relatively independent of the number of episodes or time

spent ill, and there were no differences between these patient groups in any clinical or neurocognitive variables at baseline. Also, **Pavuluri et al. [111]**, followed pediatric patients with BD for 3 years. They observed that all neuropsychological profiles remained impaired, especially EF and verbal memory even though the patients were treated and in remission. In a meta-analysis of pediatric patients with BD, it was concluded that the effect sizes of the tests in the different domains indicated greater deficits among the BD group, compared to the healthy controls, although they varied greatly in the effect size. i.e. verbal learning and memory ($Z = 4.65$, nine studies); executive function ($Z = 4.07$, nine studies); and attention ($Z = 3.81$, eight studies) [112]. However, our results differ from other researchers showing controversies in the literature about the cognitive impairment associated with BD. In a meta-analysis, **Samamé et al. [113]** described that bipolar patients' performance in 14 cognitive measures remained stable after a mean follow-up period of 4.62 years. When the meta-analysis was restricted to controlled studies, no patient-control differences were found regarding longitudinal cognitive outcomes. Also, **Cacilhas et al. [114]** found a significant correlation between age and functionality through the FAST test in BD patients. They demonstrated that BD was an important effect modifier on the natural age effects in general functioning, further characterizing BD as a chronic and impairing illness.

We must remember that this study was conducted with a clinical sample (or prevalence sample), which might tend to overestimate the morbidity, the cognitive deficits, and the functionality of patients with BD. We included in our sample patients with less than two years and more than ten years of length of illness and with very different numbers of previous affective episodes. We must also point out that, in our work, we use BD I / II patients in the same group. However, meta-analyses indicate that people with BD II also have cognitive deficits in the same way, but slightly less severe than those seen in BD I [115]; [116]. Possibly, the results of our tests would have been different if we had categorized our population into two groups. Due to the latter, patients with BD I may reflect greater severity of the disease symptoms, and therefore the effects of drugs such as mood stabilizers and antipsychotics, which are more commonly prescribed for BD I than II, and in larger doses, would produce iatrogenic effects in their EF, as noted by **Balanzá-Martínez et al. [117]**, and with greater impacts on verbal memory and processing speed as well. However, whether these discrepancies are partly related to the long-term treatment of these patients or not, is not yet fully understood. A study demonstrated that patients treated with antipsychotics had worse results in the Trail Making Test [118]. However, in another study with a

sample of 44 bipolar patients on monotherapy with lithium, it was found that changes in EF, especially in domains that required inhibitory control, were independently related to the severity of symptoms and the medication used [119]. Also, another longitudinal research with a sample of 15 euthymic patients treated with lithium monotherapy, were assessed for cognitive impairment twice over a 2-year follow-up. Repeated measures showed that the euthymic group was cognitively impaired in EF, which was the main long-term neuropsychological deficit of BD, though it did not worsen over 2 years. Furthermore, the results showed that the persistence of these cognitive deficits did not appear to be influenced by any clinical or pharmacological variable, remaining stable over time [102].

A possible alternative hypothesis of our findings is that the common cause of cognitive deficits and adverse clinical course is determined by some pathophysiological alteration (i.e. neurodevelopmental abnormalities) underlying different subgroups of patients with BD. This hypothesis is supported by the involvement of the prefrontal cortex and prefrontal-subcortical pathways, which regulate both mood state and cognitive functioning, and might predispose to a greater magnitude of cognitive deficits and frequency of episodes [120];[121]. In contrast, another subgroup of patients without such factor might have relatively preserved cognitive functioning and a lower number of affective episodes. [122];[123]; [124]; [125].

To better relate the meanings of these clinical and cognitive changes which reflected in the FAB test, we needed to initially discuss and relate the neuroanatomical and pathophysiological changes with the results found. There are several studies linking the impact of different psychiatric illnesses on brain functioning, and its architecture [126];[127];[128]. Research has shown that BD presents a cyclical and recurrent course. More recently, pathophysiological changes in the brain have been observed, raising the hypothesis that this is a progressive, chronic and disabling disease. The concept of neuroprogression appears to explain this phenomenon, but this concept is still surrounded by controversy [128];[129];[8];[9]. However, if there is an increase in the allostatic load, it produces a cumulative physiological dysregulation related to the dysfunction of the hypothalamic-pituitary-adrenal axis, altering immunity, thereby activating pro-inflammatory mechanisms with subsequent activation of oxidative stress states [130]. With this sequence of phenomena, an inflammatory environment is created, inducing a significant risk of cognitive decline [131];[132];[133];[134]. As previously reported, all these events involve a pathological

reorganization in the brain, and therefore, are associated with morphological modifications, such as the volume reduction in the cortex and white matter of the prefrontal cortex [135];[136];[137];[138];[139]. These prefrontal cortex alterations are possibly secondary to multiple episodes of mania and depression during their lives. In addition to these multiple episodes, the number of hospitalizations and disease duration in bipolar patients might cause changes in their neurocognitive performance, with an impact on their daily functionality and psychosocial aspects [4];[5];[6];[140]. These structural alterations in the prefrontal cortex, produce cognitive deficits associated with an inferior functional state, similar to what occurs to some neurological patients, indicating that some of the functional impairments frequently reported by BD patients, may be due to cognitive impairment, which may be a vulnerability factor for BD, and can present itself before the onset of the disease and worsen with the progression of the same [141].

The prefrontal cortex is a heterogeneous region that comprises several specialized sub-regions, in which EF represents only one functional category within the lobes [142]. This is a region that communicates with the entire brain, receiving and sending projections of all types. It integrates with the limbic system, reticular system, hypothalamus, and neurotransmitter systems [143], involving the amygdala, the dorsolateral prefrontal cortex, insula, and anterior cingulate areas [144];[145];[146];[147];[128];[139]. Through neuroimaging, had been possible the comprehension of the neural structure and function underlying cognitive processes and it was possible to differentiate the areas of the prefrontal cortex responsible for the different components of EF, with three main regions: the orbitofrontal, the ventromedial, and the dorsolateral region.

The orbitofrontal region, project into the caudate nucleus and is responsible for the inhibition capacity. An injury is characterized by personality change, including behavioral disinhibition and emotional lability. The ventromedial region begins in the anterior cingulate cortex and projects to the nucleus accumbens, mediating motivational behavior. An injury is associated with a decrease in motivation, causing apathy, indifference to pain, lack of motor and psychic initiative. The dorsolateral region project into the caudate nucleus. Usually, this region is associated with components of EF, namely verbal fluency, cognitive flexibility, planning, decision making, inhibitory control, working memory, reasoning, problem-solving and abstract thinking. An injury in this area, leads to the inability to maintain attention, persevering thoughts, impaired reasoning as well as deficits in mental

flexibility [148];[149];[150];[151]. The same authors observed that the neuropsychiatric manifestations are related to neurocircuitry defects. Impaired EF, impulsivity and apathy, are characteristics of frontal-subcortical circuit dysfunction, and neuropsychiatric disorders, like attention-deficit/hyperactivity disorder, obsessive-compulsive disorder, schizophrenia, and therefore BD may result from impairment that have a direct or indirect impact on the integrity or functioning of these areas and projections.

Recently, several researchers have sought to relate the six domains present in the FAB test, with different neural networks, demonstrated in **Table 10**, [54];[152];[153];[154];[155];[156];[157]. In this study, the anatomical lesions were correlated with all the FAB subtests. Executive dysfunctions and impairment in working memory are related to lesions in the prefrontal dorsolateral cortex. Abulia and apathy are related to lesions of the ventromedial cortex, and disinhibition and mood disorders are related with the orbitofrontal cortex. When applied to the FAB subtest, the conceptualization was more related to dorsolateral. The results of the conflicting instructions, and go-no-go subtests, were related to the ventromedial and orbitofrontal cortex respectively. These results found in our work are

fascinating, because each different region of the prefrontal cortex showed an altered subtest. A large number of these symptoms described above are observed daily during the care of bipolar patients, mainly during manic and depressive phases. However, the bipolar patients in our study were more than six months in euthymia. Even so, the results showed us significant losses in all functionality domains, as well as in some cognitive domains found mainly in EF. Some cognitive impairments persist even after remission symptoms, and many studies have shown that they are neuropsychological related, at least in part, to the psychosocial difficulties of these patients [91];[88];[158]. On the contrary, there is little data in literature about the use of the FAB test in bipolar patients, and it is difficult to correlate this data with the anatomical lesions analyzed. Therefore, further studies using the FAB test are necessary, to better comprehend these results. It is important to note that changes of the connections between the involved structures are critical in the emotional dysregulation and cognitive functions in BD. Researchers observed that some abnormalities in some components of these neural systems are more apparent in adolescence, while other prefrontal regions appear to progress more in young adulthood, suggesting a neurological development model for this disorder [159];[160];[37];[138];[109].

Table 10: Prefrontal cortex regions, projections, behavioral mediation and injury, correlate to different domains assessed by the FAB test in Bipolar Patients and their respective level of significance.

PREFRONTAL CORTEX REGIONS	PROJECTIONS	BEHAVIORAL MEDIATION	INJURY	FAB TEST CORRELATION	p
Orbitofrontal	<i>Caudate Nucleus</i>	<i>Inhibition Capacity</i>	<i>Behavioral Disinhibition Emotional Liability</i>	Go-No Go Task (Inhibitory control)	0.026*
				Prehension Behaviour (Environmental autonomy)	0.202
Ventromedial	<i>Accumbens Nucleus</i>	<i>Motivational Behaviour</i>	<i>Apathy Abulia</i>	Conflicting Instruction (Sensitivity to interference)	0.013*

Dorsolateral	Caudate Nucleus	Executive Functions	Verbal Fluency	Similarities (Conceptualization)	0.041*
	Basal Ganglia		Cognitive Flexibility	Lexical Fluency (Mental flexibility)	0.147
		Memory	Planning Decision Making Inhibitory Control Problem-Solving Abstract Thinking Working Memory	Motor Series (Motor programming)	0.064

FAB = Frontal Assessment Battery. Analysis of FAB subtests scores by t-test (*t*) (F) for independent samples, **p* < 0.05. (See Table 10.)

Although BD is related to cognitive deficits, these deficits do not appear to be universal. It is estimated that about 30% of BD patients in remission will have levels of cognitive performance within the normal range [161];[162]. Also, longitudinal studies have shown that fluctuations in mood states do not seem to explain many of the cognitive deficits during euthymia [163]; [164]. Thus, it becomes imperative to define whether the cognitive impairment presented during euthymia, precedes the onset of the disease, that leads to the hypothesis of alterations in the neurological development, or whether it results from the negative impact of BD on cognition that corroborates the theory of neurodegenerative process (neuroprogression). Some researchers believe in the coexistence of the two hypotheses. From a neuropsychological point of view, longitudinal studies that last more than one year, are practically non-existent, which makes it challenging to confirm the cognitive impairment and determine whether it is stable or progressive [165];[166];[35];[167];[8];[9]. One of the longer longitudinal studies with bipolar patients was performed by Santos et al. [83] which assessed the performance of 80 euthymic outpatients, using a group of neuropsychological tests and demonstrated that cognitive deficits in BD were stable during a follow-up after five years, except in verbal memory, showing that the clinical course during the follow-up period did not influence the course of cognitive dysfunction. Another important study conducted by [104], which followed-up a group of euthymic bipolar patients by 6 years, and using to evaluate the functionality the FAST test, observed that among the clinical factors, only longer illness duration was significantly related to slow processing, whereas strong relationships were observed between impoverished cognition along time and poorer psychosocial functioning. Although cognitive deficits remained stable on average

throughout the follow-up, they had enduring negative effects on psychosocial adaptation of the patients. Thus, we can hypothesize that patients with greater cognitive impairment are less able to control their disease, and as a result, they suffer a worse course of the disease. However, the presence of subtle deficits in cognitive functions provide an indication that cognitive impairment may represent a trace of vulnerability factors in the development of BD that is present before the onset of the disease, but gets worse as the disease progresses. Thus, BD is characterized by remarkable heterogeneity regarding cognitive outcomes and probably different potential clinical predictors may be related to such outcomes, i.e., previous mixed episodes, current subclinical depressive symptoms, previous hospitalizations, and old age, and should therefore be the focus to a treatment [88];[35];[168];[169]; [167];[170];[171];[172]. Also, many other studies have shown that euthymic patients continue to have difficulties at work and in their studies, showing low performance or difficulty in maintaining them, although it is less evident [173];[115];[127];[174].

Finally, one of the main objectives of this article was to correlate whether the data on cognitive deficits observed in euthymic patients can help explain functional deficits. Therefore, we attempt to evaluate the clinical capability of the FAB test in bipolar patients. Studies have shown that the FAB test may have a good capability to discriminate several conditions in different clinical populations, although the evidence is still incipient and scarce in psychiatric disorders, and the results should be interpreted with caution. After performing the Spearman Correlation Coefficient Test, by comparing the FAST and FAB test scores in euthymic patients our group was able to observe a moderate negative correlation, $r_2 = -0.53$; $p < 0.001$. This result represents that 53% of the variation of the FAST test

(functionality) is linearly related to the FAB test (cognition and EF), with the remaining 47% of the variation resulting from other factors not considered (duration of illness, time of hospitalization, number of manic or depressive episodes, among others). These results are in accordance with the literature we studied. In a systematic review of 52 studies, cognitive deficits were strongly associated with poor functioning in BD, both in cross-sectional and longitudinal studies [175]. In a meta-analysis, **Depp et al., [127]** also observed the same correlation between cognitive deficits and functional impairment. The effects did not appear to be modified either by the clinical status, or the age or design of the study. As already reported above, these cognitive deficits tend to become stable over time [113];[83]. However, a small subset of patients showed a decline over time in cognitive functions as demonstrated by **Mora et al. [104]**, after following a group of patients for 6 years. The strength of the correlation between cognition and the functional outcome depends on the tests used. **Baune et al. [175]** noticed minor effects when using the Global Functioning Assessment (GAF) Test. In a meta-analysis, **Depp et al. [127]** observed an overall mean correlation of 0.27, $p < 0.001$, and all of these previous studies corroborate our results.

As stated previously, studies on BD patients have shown that the predictors of cognitive impairment functioning, assessed by FAST, were subclinical depressive symptoms, and previous mixed episodes were strongly associated. These results support the evidence that the significant morbidity and severe clinical course of BD lead to greater cognitive impairments with long-term consequences. Several researchers have demonstrated an apparent linear relationship between the increase in depressive symptoms and functional impairments, even during subsyndromal depressive conditions, which would increase the likelihood of depressive relapses. This is due to a stabilization meantime for bipolar depression, which is 24 weeks, while patients with mania need 11 weeks, and patients with mixed cycling episodes need 40 weeks [176];[177];[178];[179];[167];[170];[172]. **Rosa et al. [24]** concluded the same results, indicating that depressive symptoms are associated with a greater negative impact on psychosocial functioning than manic (hypo) symptoms. Other deficits in functioning seem to persist even during remission. These results showed the importance of treating depression and mania early, and the need to develop psychosocial interventions to improve functional results. The use of traditional psychopharmacology associated with psychoeducation has allowed the remission of the clinical symptoms to remain stable for more extended periods, which is an achievable

goal for many BD patients. However, it is no longer just about improve the patients or their remitting symptoms; but mostly improve their recovery. Unfortunately, studies showed that psychoeducation did not alter neurocognitive functioning on a neuropsychological test battery when compared with treatment as usual or cognitive behavioral therapy in altering dysfunctional negative beliefs [180];[181];[182];[183];[67]. Although our patients were participating in a psychoeducation group for more than two years, we observed similar results in our study, with many significant alterations in the cognitive and functional domains. Thus, the mood stability must come with the improvement of the processing speed, of the memory, and the EF, in addition to better psychosocial, interpersonal, and occupational functioning. These are fundamental objectives to be achieved.

V. CONCLUSION

As far as we know, this is one of the first studies that used the FAB test to assess the influence of various demographic and clinical variables, related to executive dysfunctions in BD. Although we adopted relatively strict inclusion criteria in our study, we recognize that our results should be evaluated with caution due to several limitations, which mainly derived from the administered neuropsychological tests, the sample size, and the cross-sectional design of the study. However, the limitations of the FAB and FAST tests, as well as the sample size, were partially resolved through the inclusion of a healthy control group, and the statistical evaluation regarding the sample sizes. Besides the above mentioned, there is also the clinical heterogeneity of the sample, which included patients with short- and long-term illnesses, who had different levels of education and age, which interfered in the analyzes. Another limitation was our cross-sectional design, where the data did not allow the analysis of the cause-and-effect relationship, and also studying many variables and their different areas of functioning. Regarding the FAST test, we did not control factors that could affect functional outcomes such as psychosocial interventions, familiar support, housing, and financial resources. The last weakness of our work is the lack of a deeper analysis regarding the impact of the treatments and medications used. As these patients have a chronic disease, they have had several previous treatments that may be related to current cognitive and functional deficits. This will be evaluated in future research that is already being planned. Thus, a larger sample can improve the performance of the FAB test, in addition to a better division into more clinically defined subgroups and a better control of some variables. Furthermore, our group started a new study with bipolar patients who had early and late-onset of the disease, and we are trying to assess

the functionality and cognitive impairment of these patient groups, continuing to include and controlling more variables.

However, the so-called euthymia in the BD does not mean full recovery of the patient, and this was very clear in our group during this study. Most of our bipolar patients participated in a psychoeducation program for more than 2 years, and all were outpatients with more than 6 months of euthymia. Therefore, we expected a better response to the FAST and FAB test scores compared to what was observed in other studies. However, the present study revealed that the data of our euthymic patients showed similar deficits in specific cognitive components, and these were associated with all domains of the FAST test, showing similar results with the literature.

Despite the clinical interest, there is a gap in terms of studies of the FAB test in bipolar patients, impairing the assessment as reliability and as validity that can correspond clinically. Although the FAB test shows some limitations, there is some evidence to suggest that several FAB test domains may have good predictions. In terms of clinical practice, early and differential diagnoses are crucial elements in determining the appropriate treatments and therapies. In this sense, the FAB subscores can offer useful information to increase the accuracy of the diagnosis, which can also be of considerable importance during advanced stages in which the progression of the disease intensifies executive dysfunctions. The total performance of the FAB test can be used as a marker of severe disease, rather than a single screening test. Furthermore, we can evaluate the effectiveness of neuropsychological rehabilitation programs in future studies, measuring the results and the qualitative analysis of their performance and also associate the impairments observed in cognitive functioning with possible brain dysfunctions. Following these strategies, it is necessary to promote functional recovery, which in many cases is not achieved through the available treatments today, which focus mainly on stabilizing mood episodes and preventing possible relapses. So far, there is no specific therapy or approaches to prevent the onset of this disorder or to treat it at the beginning of the disease. Many techniques have been developed to improve cognition in neuropsychiatric diseases. However, more recently, new approaches, such as functional remediation and dialectical behavior therapy (DBT), have been used. These techniques cover psychosocial aspects and regulations of emotions [184];[185];[186]. Functional remediation seeks to improve aspects related to work, functional and interpersonal skills, increasing autonomy, and reducing financial dependence. On the other hand, the core of DBT is to help people build four essential skills: mindfulness,

distress tolerance, interpersonal effectiveness, and emotional regulation. Recently these new approaches have been used to treat patients with BD [187];[188];[189]. Thus, through this research, our group aims to select patients for a future study about DBT, allowing them to develop new behaviors and skills. Thus, we aim to prevent and minimize the impact of any deficits found in their daily lives through cognitive training, and thus, promote their future reintegration into the community, improving their quality of life and reducing health expenses through the prevention of relapses.

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Production of Interlocked block with added Tire Rubber Waste

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Keywords— Resistance, Residue,
Paving.

Abstract— Currently, much is being studied about the inappropriate disposal of useless tires, where it causes many health and environmental problems. Therefore, the work aims to develop a research on a very important topic, which is the reuse of tire rubber residue, which will be crushed and replaced by fine aggregate (sand), for the production of interlocking blocks for paving. For this, bibliographic searches, queries on articles and standards will be carried out, where the bodies of evidence will be made, conventional blocks (blocks without the addition of rubber), the other mixtures with rubber residue, the sand will be replaced by the residue in the following percentages 2, 5%, 5%, 7.5% and 10%, and axial compression will be tested at 7, 14 and 28 days of curing. With all this, the resistance of conventional blocks will be compared with blocks with the addition of rubber. And with the test results obtained, check if it meets the standard required by NBR 9781 (ABNT, 2013), for the production of interlocking blocks.

Resumo— Atualmente muito se estuda sobre o descarte inadequado de pneus inúteis, onde causa muitos problemas sanitários e ambientais. Diante disso, o trabalho tem como finalidade desenvolver uma pesquisa sobre um tema muito importante, que é a reutilização de resíduo da borracha do pneu, que será triturada e substituído pelo agregado miúdo (areia), para a produção de blocos intertravados para pavimentações. Para isto, serão realizadas pesquisas bibliográficas, consultas em artigos e normas, onde serão feitos os corpos de provas, blocos convencionais (blocos sem adição da borracha), as demais misturas com resíduo da borracha, a areia será substituída pelo resíduo nas seguintes porcentagens 2,5%, 5%, 5%, 7,5% e 10%, e será ensaiado a compressão axial aos 7, 14 e 28 dias de cura. Com tudo isso será comparado a resistência dos blocos convencionais com os blocos com adição de borracha. E com os resultados do ensaio obtidos, verificar se atende a norma exigida pela NBR 9781 (ABNT, 2013), para a produção dos blocos intertravados.

Palavras-chave— Resistência. Resíduo. Pavimentação.

I. INTRODUCTION

Currently in Brazil, interlocking blocks have been gaining a lot in the civil construction market, these blocks have been used mainly in sidewalks, squares, parks, streets and patios. The advancement of interlocking blocks and due to their characteristics, among them are the low maintenance cost, the removal of blocks in paved areas and the reuse of

approximately 95% of the pieces. Subsequently running the floor can have instant traffic of people and vehicles, there is no need time d and healing and has varieties of both formats as colors. The interlocking floor blocks vary in thickness, 6 cm and 10 cm. The 6 cm pieces are used for lighter traffic such as: light vehicles, pedestrians and bicycles, since the traffic is more intense, the 8 cm and 10

cm blocks are used where the traffic is much heavier, such as: buses and ways. The structure of the interlocked pavement will depend a lot on the traffic intensity applied on the pavement, the soil has characteristics that make up the subgrade. The base of the interlocking pavement is composed of several layers: rolling layer, laying layer, base, sub-base and sub-grade.

The use of the rubber tire brought many serious health and environmental problems, because when tires become useless, the tires are discarded in inappropriate places, causing great disturbances to people's health and quality of life. The improper disposal of tires has many serious consequences, occupations of large spaces in landfills, increased risk of fire, proliferation of insects that can transmit serious diseases and the silting up of rivers and lakes (RAMOS, 2005). Taking into account law no. 258, of August 26, 1999, of the National Environment Council - CONAMA (BRAZIL, 1999), the Minister of the Environment has a requirement that tire manufacturers and importers have to collect and dispose of tires, environmentally appropriate, waste tires existing in the national territory. The fact is of fundamental importance, as it forces companies to look for logistics that are contrary to the recycling activities and reuse of their products.

According to Rodrigues and Santos (2013), due to the characteristics of rubber, such as lightness, thermal properties, elasticity, energy absorption and acoustic properties, recycled rubber tire aggregates are very promising in the construction industry. It is possible to deduce that every tire at some point will turn into a waste that is harmful to health and the environment, and recyclable material would be the most suitable solution. However, reuse requires in-depth knowledge of the technical and technological aspects of the environment and

the performance of the tire as a construction material. To soften the impact on nature, the addition of crushed rubber and the mixture in the production of interlocking floors is a solution, the floor better known commercially as pavers.

II. DEVELOPMENT

2.1 Materials and Methods

The tire waste (crushed rubber) (Fig.1a) used in this investigation came from the tire resurfacing process in the city of Porto Nacional / TO / Brazil. The rubbers were collected in eight 50 kg bags, after which they were classified in an ABNT sieve according to NBR 248 (Determination of the granulometric composition), where the material retained in the 1.2 mm sieve, the crushed rubber, was used. Gravel powder and washed sand were used as natural aggregates and were sieved using the No. 200 sieve according to (ABNT) to discard contaminating materials. All materials were oven dried for a period of 24 hours at temperatures of ($105^{\circ} \sim 110^{\circ} \text{C}$) and cooled to room temperature so that there is no influence of the natural humidity in the results. Portland cement CPPII-F 32 ABNT NBR 7211/2005 was used as a binder. The water was supplied by the sanitation company network in the state of Tocantins.

The concrete mix was formulated: 1: 1.68: 2.68: 0.482 (cement, sand, gravel powder, water) to show resistance to uniaxial compression of 20 MPa at 28 days of curing. Five cylindrical specimens (10 cm x 20 cm) were developed for each concrete formulation with the addition of crushed rubber. s compression tests were performed at 07, 14, 21 and 28 days according to ABNT NBR5739 (concrete - cylindrical specimen compression test). The investigated dosages with the addition of rubber are shown in Table 1.



Fig.1: (a) crushed rubber, (b) sand, (c) gravel powder, (d) Portland cement.

Table 1. Formulation of concrete dosages with the addition of rubber.

Sample	Rubber grease(%)
CP-0	0
CP-2,5	2,5
CP-5	5
CP-7,5	7,5
CP-10	10

CP - Reference specimen without the addition of rubber.

III. RESULTS AND DISCUSSIONS

3.1 Compressive strength

The results presented by the sample without the addition of the crushed rubber (CP0) were used as a reference to evaluate the results presented by the samples with the addition of the crushed rubber (CP 2.5, CP5, CP7.5 and CP10). The results presented for the compressive strength test for the control specimens and those added with rubber can be seen in figure 2.

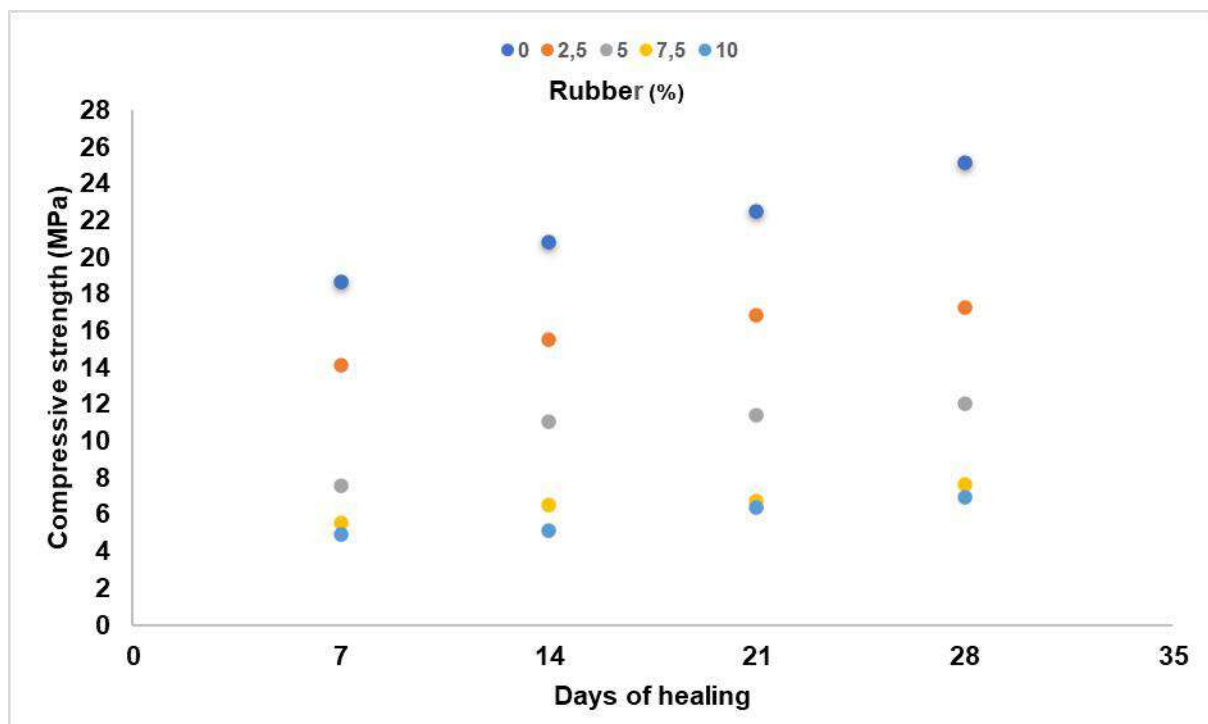


Fig.2: Resistance to uniaxial compression of samples with the addition of rubber: 2.5%, 5%, 7.5% and 10% replacing the aggregate.

After the rupture of the specimens with the hydraulic press, the results sketched in figure 2 shows that the greater the addition of the crushed rubber to the concrete, the lower the compressive strength, therefore, the size of the rubber particles also influences the important performance affect the porosity of resistance. The reduction of resistance with the increase of the rubber content in the investigated specimens can be attributed to three main reasons: weak interfacial bond between the rubber particles of the tire and the cement matrix, deformability of the rubber particles in relation to the microstructure surrounding cement, resulting in the beginning of cracks in a pattern similar to that of air voids in normal concrete and possible reduction in the density of

the concrete matrix that still depends on the size, density and hardness of the aggregates.

IV. CONCLUSION

The results presented by the tested samples in relation to the compressive strength, show that it is possible to use the tire residue (crushed rubber) as aggregate in the non-structural concrete in partial replacement of the washed sand with addition 2.5%, 5%, 7, 5% and 10% for the production of interlocking blocks for the use of sidewalks, roads, cycle paths, squares, parks and garages. The greatest contribution of adding this residue to the concrete mass is

the reduction in density ($\pm 26\%$) when compared to traditional concrete.

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Analysis of Sea Border Crossing Transportation Between Three Countries in Sumatera Island, Case Study: Tanjung Balai Karimun Port – Harbour Front Port, Singapore and Tanjung Balai Karimun Port – Kukup and Puteri Ports, Malaysia

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Keywords— Ferry, Harbour Front, Kukup Port, Puteri Port, Sea Border Crossing, Sumatera Island, Tanjung Balai Karimun.

Abstract— Indonesia water area is connecting cities, islands, and countries as border in Sumatera Island involving 3 countries. They are Indonesia, Malaysia and Singapore. This research was conducted to inventories safety concern in sea crossing transportation in Sumatera Island especially in the border between Indonesia, Malaysia and Singapore, also to analyse safety and security standard of sea border crossing transportation by reviewing safety equipment in the sip and condition of sea crossing ports at the border of Indonesia, Malaysia and Singapore. Beside Batam, Tanjung Balai Karimun also serves passenger ferry to Singapore and Malaysia. This research is expected to identify safety equipment in ferries serving Tanjung Balai Karimun – Singapore (Harbour Front Port) and also Tanjung Balai Karimun – Malaysia (Kukup and Puteri ports) to prevent future sea transportation accident.

I. INTRODUCTION

Physical activities connectivity after implementation of ASEAN Economic Community in 2015 has been the focus of ASEAN countries in transportation field. All ASEAN countries work together to make it into reality, especially in transportation infrastructure. ASEAN countries agree to develop roll on-roll off (ro-ro) ferry transportation networking system in South East Asia. ASEAN countries agree to establish eight ro-ro ferry transportation systems.

These eight systems are Zamboanga City (Mindanao, Philippines)-Muara (Brunei Darussalam), Davao City-General Santos (Mindanao, Philippines)-Bitung (Sulawesi, Indonesia), Johor (Malay Peninsula, Malaysia)-Sintete

(Kalimantan, Indonesia). Then, Tawau-Tarakan (Indonesia)-Pantoloan (Sulawesi, Indonesia), Brooke's Point (Palawan, Philippines)-Labuan (Malaysia)-Muara (Brunei Darussalam), Dumai (Sumatera, Indonesia)-Malacca (Malay Peninsula, Malaysia), Belawan (Sumatera, Indonesia)-Penang (Malaysia), and Phuket (Thailand)-Belawan (Sumatera, Indonesia).

But in reality on the field, especially in previous research, these ro-ro ferry lines are not/haven't been detected. What are known are passenger ferry lines, even those are not yet integrated between Thailand, Philippines and Brunei (no research has been conducted). The well-integrated are passenger ferry lines between Singapore, Malaysia and Indonesia, particularly in Batam, Nunukan in

Indonesia with Tawau in Malaysia, also Tanjung Balai Karimun with Malaysia in Johor and Singapore. as for Sumatera island, beside Batam, there are several cities in Sumatera island close to Batam, they are Tanjung Balai Karimun that is also serving passenger ferry to Singapore and Malaysia, and dan Dumai – Melaka in Malaysia. This research will study condition on the field of shipping nd ferry terminals/ports particularly Tanjung Balai Karimun, Harbour Front in Singapore, and Kukup-Puteri in Malaysia.

II. LITERATURE STUDY

According to United Nation Convention on the Law of the Sea (UNCLOS) Number 17/1985 every citizen of flag member state must conduct administration, technical and social activities based on effective jurisdiction-supervision on board the sip of flag state. Therefore, every member state has to:

- a. Maintain registered flag state ships and non flag state ships carrying the flag, kexcept ships exempted from accepted international law due to small=non standard size,
- b. Conduct jurisdiction under its national aw concerning ships flying its flag and to captain/skipper, crews with regard to administration, technical and social matters on board the ship.

Furthermore, each member states shall take necessary action for ships flying its flag to guarantee safety sea regarding:

1. Construction, euipment and seaworthiness of the ship;
2. Shipmanning , labor requirement, ship crew training by considering following applied international provision ;
3. Use of signs, , maintenance of communication and collision prevention.

According to International regulation:

SOLAS (Safety of Live At Sea), there are arrangements on:

- Safety action to prevent fire on passenger ship carrying more than 36 passengers (Chapter II-2 rule 17-34).
- Safety action to prevent fire on passenger ship carrying less than 36 passengers (Chapter II-2 rule 35-50).
- Safety equipments for passenger ship (ChapterIII rule 27-34).

SOLAS also arranges:

- Construction (structure, stability, mchinery, electrical installation , fire safety, fire detector and fire extinguisher).
- Radio communication and navigation system.
- Personal safety equipment like ring buouy, safety jacket etc.

ASEAN countries agree on three main projects of Ro-Ro vessel that connect island nations in south East Asia. This policy should have been implemented in 2015. Those three routes of Roll-On Roll-Off. Ro-Ro vessel are Dumai—Malaka (Malaysia), Belawan—Penang (Malaysia)—Phuket (Thailand), and General Santos/ Davao (Philippines)—Bitung (Indonesia). Previous research has identified sea crossing of Davao – Bitung and research between three countries of Indonesia, Malaysia, Thailand. So far, some projects in IMG-GT format are Ro-Ro ship crossing routes of Malaka (Malaysia) – Dumai (Indonesia), Belawan (Indonesia) – Penang (Malaysia) – Phuket (Thailand). The well-integrated are passenger ferry lines between Singapore, Malaysia and Indonesia, particularly in Batam, Nunukan in Indonesia with Tawau in Malaysia, also Tanjung Balai Karimun with Malaysia in Johor and Singapore. as for Sumatera island, beside Batam, there are several cities in Sumatera island which are close to Batam like Tanjung Balai Karimun that is also serving passenger ferry to Singapore and Malaysia.

III. RESULT AND DISCUSSION

The In order to integrate facility and infrastructure of transportation that meet safety and security standard of transportation particularly in border areas with neighboring countries safe secured, and passenger-convenient transportation system is totally needed. This system is also for cargoes movement between countries and to sustain continuous development on sea transportation with regard to Law Number. 17/2008 on shipping, In general provision, safety and security touches water transportation, harbor /port matters, and maritime environment. In that regard, all parties involved in shipping shall meet determined requirement.

In safety and security of sea crossing transportation framework, especially between Indonesia, Malaysia and Singapore, condition of utilized ship will be reviewed. Safety equipment available in the ship should refer to SOLAS. The review also covers the terminals condition in Tanjung Balai Karimun, Harbour Front, Singapore, Kukup and Puteri ports in Johor, Malaysia from safety concern, also they should be adequate and feasible for passengers.

3.1. Overview of city and Port of Tanjung Balai Karimun

Karimun Regency is in Riau islands Province, Indonesia. It has total size of 7.984 km² consisting of 1.524 km² land size and 6.460 km² water area. This regency has 98 islands 67 are inhabited. The population is 174.784. It has border with Meranti islands on the west, Pelalawan and Indragiri Hilir on the south, Malaka strait on the north and Batam city on east.

Tanjung Balai Karimun is the capital city of Karimun regency in Riau islands province. This Tanjung Balai city is located in south east of Karimun islands and in general is part of BBK (Batam-Bintan-Karimun) free trade zone which is quite strategic due to its international sea shipping line, west side of Singapore. This city is close to Sumatera island mainland (Riau province) also with Malaysia. The establishment of Karimun business body will provide accurate and detailed information on potentially growing business.



Fig.1: Map of Karimun Regency

Tanjung Balai Karimun port has been existing since 1958. its operation has been under management of P.T. Pelabuhan Indonesia I (Persero) since 1998 and appointed as port branch class III based on Director decision of P.T. Pelabuhan Indonesia I (Persero) No. OT.09/1/2/PI-98 dated January 16, 1998. Then it was upgraded to class II, in 2009 by Directors Letter PR 02/3/II/PI-09 dated August 18 2009. This port is located in big Karimun island at geography of 00° 59' 17" LU and 103° 26' 14" east Longitude, generally is part of Karimun regency administration.

Tanjung Balai Karimun port is economic gateway in Riau islands and as the integration of inter transportation and transportation type particularly inflow and outflow of ships, cargoes and passengers. Tanjung Balai Karimun port is entrance gate in Karimun island and as international port particularly from Riau islands to Singapore and Kukup, Malaysia.

Tanjung Balai Karimun port, is located in Karimun island. Tanjung Balai Karimun port is one of port branch managed by P.T. (Persero) Indonesia Port I headquartered in Medan. As one of branch, geographically the location has direct border with neighboring countries Malaysia and Singapore, known with Malaka strait and Singapore strait as the most crowded and busiest in the world. These both straits are "Straits Used for International Navigation" according to international sea law definition (UNCLOS). Given this condition, Tanjung Balai Karimun port has significant role from economic activities by way of sea transportation of ships for loading-unloading cargoes and passengers.



Fig.2: Map of Tanjung Balai Karimun



Fig.3: Schedule and ticket booth of ferry in Tanjung Balai Karimun

3.2. HarbourFront Centre port, Singapore

Tanjung Balai Karimun-one of cities that is closest to our neighboring country Singapore has four ferry trips every day from Tanjung Balai Karimun ferry terminal to Harbour Front Singapore. The shipping operators are Indo Falcon and Sindo Ferry. Likewise, from HarbourFront Singapore to ke Tanjung. Balai Karimun, it has a4 Ferry trips, opetated by same operators, Indo Falcon and Sindo Ferry.

Trip from TanjungBalai Karimun to HarbourFront Singapore is 1 hour 30 minutes. Harbour Front port is modern and already integrated with mall, so this accommodates passengers who want to do sightseeing /tour and shopping in Singapore.



Fig.4: HarbourFront port, Singapore

3.3. Kukup Ports, Malaysia

Kukup ferry terminal is located in fisherman villain Pontian district, Johor. Distance from Johor Bahru is around 40 km, and it serves ferry crossing to Indonesia particularly to Tanjung Balai Karimun.



Fig.5: Kukup ferry Terminal, Malaysia

Kukup Malaysia is one of fisherman villages and travel/tour destination in Johor Malaysia. there are many resorts and restaurants in Kukup. The resorts provide various recreational activities and the restaurants provide seafood. Kukup terminal is also as transit point for

Karimun island residents who want to visit other areas in Malaysia.



Fig.6: Distance from Tanjung Balai Karimun- Kukup port

Trip from Tanjung Balai Karimun port to Kukup Malaysia is on around 1 hour.

Puteri Port, Malaysia

Puteri port Johor is a port closest to Hello Kitty Town and Legoland amusement parks in Johor Malaysia. Residents of Karimun and the surroundings who want to tour to both parks can use ferry that serves Tanjung Balai Karimun – Puteri port Johor Malaysia. The trip is around 1 hour and 20 minutes (80 minutes).

There are 4 trips from Tanjung Balai Karimun to Puteri port Johor Malaysia and viceversa. The earliest trip from Tanjung Balai Karimun is 08.00 WIB and the latest is 15.45 WIB. While from Puteri port Johor Malaysia to Tanjung Balai Karimun, the earliest is 08.00 Malaysia time and the latest is 16.30 Malaysia time.



Fig.7: Distance from Tanjung. Balai Karimun – Puteri port



Fig.8: Puteri port Johor, Malaysia



Fig.9: Ferry ship that serves Johor – Tanjung Balai Karimun

IV. CONCLUSION

Based on the research, it can be concluded that:

1. Port at Tanjung Balai Karimun is still conventional given its old building and non-modern equipment. This

port needs to be modernized because it is travel destination for Singapore and Malaysia citizens.

2. Ports in Malaysia especially Puteri port is appropriate as ferry port and there is mall around the port and travel destinations especially in Johor Bahru.
3. Port in Singapore is modern and integrated with travel/tour destination so tourists from many countries will make it their destination.
4. Ships serving Malaysia and Singapore are ferry ships generally run around 1,5 - 2 hours, and use adequate facilities and appropriate for safety equipments.
5. Relatively no accident has ever happened even though there still minor matters because sometimes sea animals/plants are stuck in the propeller but this can be handled well. Generally shipping lines of Tanjung Balai Karimun to Singapore and Malaysia are relatively safe.

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Comparative study of the costs of implementation of three types of photovoltaic energy systems in the city of Porto Nacional - TO

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Keywords—Energy, Photovoltaic, Solar.

Abstract—It is known that the world is at a time when society is increasingly seeking to adapt to the means of sustainable development as a way of preserving the environment and maintaining balance so that there is no depletion of the energy resources present in the world. One of these means is solar or photovoltaic energy, which is based on the conversion of energy that is radiated by the sun into electrical energy by means of photovoltaic cells, distributed in panels that are part of the photovoltaic generation system. The present work aims to carry out a comparative study of the cost of implantation of the solar energy system with methods of structures with active, chronological and sensor trackers. Implementation costs were assessed, in addition to identifying the efficiency of each system along with advantages and disadvantages.

I. INTRODUCTION

Solar energy is a type of renewable energy that is obtained through the sun and can be used as a source of electrical energy or even for heating water. Its use has been growing all over the world because it is one of the cleanest forms of energy production. It is used in various media and different technologies that are constantly changing, among them are solar heating, solar photovoltaic energy, hydrothermal energy, solar architecture and artificial photosynthesis.

The conversion of solar energy into electrical energy takes place through the photovoltaic effect process (*Photo* which) using a surface that is composed of a semiconductor material that has the name of a photovoltaic panel. The electrical voltage that occurs is caused by the excitation of electrons in the semiconductor material due to the incidence of photons that are components of solar radiation.

With each passing day, the human being has been looking for renewable means to maintain himself without harming the environment so much, and with that the solar

energy trade is growing all over the world. Therefore, the business of this type of material grows with several options.

There are panels with trackers and those that are fixed. The tracking types seek the energy that comes from the sun by tracking its movement and thus capturing a greater amount of it, since it is always towards the sun. The fixed type is only in one position to capture the energy.

The present work aimed to assess the costs of implementing three types of solar energy system, being active, which guides the panels towards the maximum light intensity, by sensors, which work under the principle of the difference in lighting and the chronological, which is based on date and time, also verifying the efficiency of each one of them and their advantages and disadvantages in relation to maintenance costs in the medium and long term.

II. TEORETICAL FRAMEWORK

SOLAR ENERGY

Photovoltaic solar energy is obtained by converting solar radiation into electricity using semiconductor materials. This phenomenon is known as the Photovoltaic Effect (BRAGA 2008).

He knows that this effect was first explored in 1839, by the Frenchman Edmund Becquerel, in a solution of selenium. He observed the appearance of a solution between the conductive solution electrodes, whenever it was illuminated by sunlight. In 1870, this effect was studied in solids and in the middle of 1880 the first photovoltaic cell was built using selenium.

SOLAR ENERGY IN THE WORLD

The main branches of use of solar energy internationally are for heating water and generating electricity under photovoltaic effect.

Bandeira (2012) explains that regarding the application of solar energy to water heating, according to information from the Atlas of Electric Energy of Brazil - 3rd Edition 5, for a long time Israel was the only country to require a minimum participation of water heating from solar energy. As of 2006, Spain assumed a similar stance and began to require minimum levels of solar energy for both water heating and electricity generation in new constructions such as residential buildings, hotels and hospitals. In 2007, the initiative was followed by countries such as India, South Korea, China and Germany. The required percentages range from 30% to 70%, depending on the climate, level of consumption and availability of other energy sources.

All the growth in installed heater capacity solar water and photovoltaic panels in the world is heavily subsidized. In the several countries where there is significant growth in the use of solar energy, both manufacturers and investors in equipment for capturing and converting solar energy have tax benefits and incentives in electricity tariffs (FLAG, 2012).

SOLAR ENERGY IN BRAZIL

As in other countries, in Brazil the main means of using solar energy are to heat water and to generate electricity through the photovoltaic effect.

According to Rella (2017), the installed capacity in Brazil, taking into account all types of plants that produce electricity, is in the order of 132 gigawatts (GW). Of this total, less than 0.0008% is produced with solar photovoltaic systems (they directly transform sunlight into electrical energy). Photovoltaic generation in the country is residual compared to other sources, such as wind.

According to the Energy Research Company - EPE, if Brazil took advantage of all the existing solar potential, there would be a production of 283.5 million MW per year of photovoltaic energy. Thus, this power would be able to supply more than twice the current domestic consumption of 128.8 million MW per year in the country.

Brazil currently has more than 20,000 companies operating in the field of solar energy, according to Portal Solar. The sectors that stand out the most are equipment manufacturers and installation services for distributed generation, and the main companies are concentrated in the state of São Paulo.

According to the National Electricity Agency (ANEEL), the forecast is that, in the year 2024, the country will reach 886 thousand consumer units with a total installed power of 3,208 Mega Watts.

SOLAR ENERGY IN TOCANTINS

The use of solar energy in Tocantins increased by 30% in 2018, mainly during periods of drought. The installation of solar panels in the region helps residents to save on electricity costs, in addition to contributing to the environment that is already so devastated, further favoring the use of ecological means.

The state of Tocantins, according to the Atlas Solarimétrico, has high levels of solar incidence, which helps to directly contribute to the great efficiency of photovoltaic panels and the generation of clean and renewable energy. Thus, Tocantins is characterized as the state that has the best solar radiation in the northern region of Brazil, constantly increasing the development of the use of technology in homes and commercial establishments.

NBR 16690

NBR 16690 - Electrical installations for photovoltaic arrays - Design requirements - published on 10/03/2019, establishes the design requirements for electrical installations for photovoltaic arrays, also includes the provisions on conductors, electrical protection devices, switching devices, grounding and equipotentialization of the entire photovoltaic arrangement. It includes all parts of the photovoltaic array up to energy storage devices, power conditioning units or loads.

BOARDS WITH ACTIVE TRACKERS

According to Queiroz et al. (2018), active tracking systems have a set of motors and sensors that are capable of orienting the panels towards the maximum light intensity. How electricity production is directly related to the incidence of energy light, active tracking improves system efficiency. They are usually based on a pair of photosensitive elements capable of varying the level of

some electrical quantity according to the incident light radiation.

The active type tracker includes the use of one or more electric motors in each of the tracking axes of the mechanical support of the photovoltaic modules. The motors are controlled by means of an electronic circuit that receives data from the position of the sun through sensors (MONTEIRO, 2007).

Active solar trackers can track the sun on one or two axes. The one-axis tracker has a single axis in the North-South direction, around which the photovoltaic array rotates to align with the sun throughout the day. In the case of the two-axis tracker, there is also a second axis in the East-West direction that allows the arrangement to adjust its inclination to suit the different inclinations of the sun throughout the seasons (OLIVEIRA, 2007)

PLATES WITH SENSORS AND CHRONOLOGICAL TRACKERS

The main feature of the tracking strategy based on micro controlled optical-electric sensors is the use of a processing unit and at least two optical sensor units, which work under the principle of difference in illumination. The tracking strategy based on date and time is characterized by the use of formulas and algorithms sensors, geographic location as well as local time, as inputs to the controller, which generates signals for the system's guidance mechanisms (QUEIROZ et al., 2018).

Chronological trackers rotate according to the apparent speed of the sun. The revolution of the sun is 360° in 24 hours, so the structure of the panel must rotate at a speed of $15^\circ / h$ during the period of sunshine. Therefore, this form of tracking can receive the location information as parameters and perform the calculation of the positioning of the sun in its code and send a control signal for the engines to actuate (GODOY, 2019)

SOLAR LOCATORS

The solar tracking system needs locators to work. As a type of locators, we have the physical, hybrid and software locators.

Physical locators are devices that have sensors that can read the solar location and thus transmit this data so that the panel can be located. Its greatest benefit is the ease of implementation of the system, and its disadvantage is that it is only valid at times when the sun is not covered.

The software locators are equipment that can be programmed to perform the movement of the panel to a certain position, the panel will have a certain position at a certain time of the day, this movement is already pre-established for all changes in the sun both in the daily as annual period. Its greatest benefit is the possibility of using

it even with the sun overcast, since the panel will continue its automatic path, since its obstacle would be the cost of implementation due to the complex programming that involves it. The main equipment that can perform this routine are micro controllers, PLCs and microcomputers. And the hybrid locators are those that move through software and hardware, with the advantage of the system's credibility, since even with weather-related setbacks, it continues to move. As a disadvantage, it has the high cost of implementation, since sensors and microcontrollers need to be implanted (KUHN, 2013, page 30).

MAINTENANCE OF THE MODULES

Maintenance is the set of actions responsible for keeping the mechanisms in operation, these actions involve conservation, adequacy, restoration, replacement and prevention. Without a good maintenance program, the losses caused by defective equipment are high due to delays or interruptions in production, which can cause market loss due to customer dissatisfaction (CARMO, 2019).

According to Greco (2006), the maintenance activity needs to be efficient and effective; that is, it is not enough to just repair the equipment or installation as quickly as possible. It is necessary to maintain the function of the equipment available for operation, avoid equipment failure and reduce the risks of an unplanned production stoppage.

Maintenance can be divided into two groups that are separated into scheduled and unscheduled maintenance.

Unscheduled maintenance, also known as corrective maintenance, is one in which a repair or replacement of a part is carried out due to the occurrence of an unforeseen failure. This type of maintenance is practiced only after the equipment or the machine is damaged. Corrective maintenance is not recommended as the main maintenance strategy. Preventive maintenance consists of a set of procedures and early actions that aim to keep the machine running. It is assumed that the maintenance service can be planned in terms of number of hours of machine operation or even a total elapsed time, in hours, year, cycles, mileage traveled, capacity produced among others. The main advantages of this type of maintenance are the lower occurrence of sudden breaks and the fact that the stops are planned. On the other hand, unnecessary work may occur and defects still occur once the maintenance program takes into account only the average conditions of the plant's equipment, based on the manufacturer's history and / or recommendation (CARMO, 2019, page 19).

ECONOMIC FEASIBILITY

According to CARMO (2019), for an economic feasibility analysis of the solar tracking system, the gain in energy generation obtained from the use of the solar tracking system is converted into a monetary value. Concomitant to this, maintenance costs are also estimated. With this data, it is possible to determine the payback period for the investment or Payback.

Payback is not always the most used tool for decision making, however it is a technique that can be used in the evaluation of investment in view of cash flow over time. The recovery period is the time that the investment takes to be recovered according to the discounted cash flow. Based on the assumption of these data, it is possible to infer about the economical viability of the solar tracking system.

III. MATERIAL AND METHOD

The costs of implementing the fixed system and the system with solar energy trackers were measured, being active, by sensors and the chronological through surveys in the solar energy companies in the city of Porto Nacional and region using the connection method phone and email.

The collection of data to compare the costs of implementing solar systems occurred in the months of March and April of the year 2021. The budgets were made in two companies. The costs of the fixed system were measured at the company Portal Solar and the costs of the system with trackers were researched at the company Ouroflux Solar.

In the beginning, it would be necessary to define the average powers in order to continue with the budget, and thus the powers of 500, 1500 and 3000 KWh / month were chosen. Thereafter, the costs of materials were requested along with the installation for each of the two selected companies. The basis of comparison was in soil structure, since it is closest to all the models that will be analyzed.

IV. RESULTS AND DISCUSSION

The company Portal Solar, made available the budget with the cash price and financed. It also contains the number of panels required for the power and minimum area required for their installation. Ouroflux does not provide the installation, only the equipment.

Table.1: Fixed solar system budget for an average monthly production of 500 kWh

FIXED SOLAR SYSTEM	
MONTHLY PRODUCTION	500 KWh / month
INSTALLED POWER	4.1 KWp
MINIMUM AREA REQUIRED	32.8 m ²
QUANTITY OF PANELS	10 of 405 W
SUMMARY VALUE	24,127.09 reais
FINANCED AMOUNT	72x from 586.77 reais

Table.2: Fixed solar system budget for an average monthly production of 1500 kWh

FIXED SOLAR SYSTEM	
MONTHLY PRODUCTION	1500 KWh / month
INSTALLED POWER	11.3 KWp
MINIMUM AREA REQUIRED	90.4 m ²
QUANTITY OF PANELS	28 of 405 W
SUMMARY VALUE	51417.23 reais
FINANCED AMOUNT	72x from 1250.47 real

Table.3: Fixed solar system budget for an average monthly production of 3000 kWh

FIXED SOLAR SYSTEM	
MONTHLY PRODUCTION	3000 KWh / month
INSTALLED POWER	23.5 KWp
MINIMUM AREA REQUIRED	188 m ²
QUANTITY OF PANELS	58 of 405 W
SUMMARY VALUE	24,127.09 reais
FINANCED AMOUNT	72x from 2497.88 reais

The company Ouroflux solar, when providing the cost estimate of the system with trackers, also provided the value of the freight. This budget does not include the installation, only the material. The form of payment provided by the company is only anticipated. All systems are connected to the network, better known as On Grid and their monitoring is done via the software of each inverter.

Table.4: Solar system budget with trackers for average monthly production of 500 kWh

SOLAR SYSTEM WITH MONTHLY	
PRODUCTION TRACKERS	500 KWh / month
VALUE MATERIALS	R \$ 12376,77
FREIGHT AMOUNT	R \$ 618.84

TOTAL	R \$ 12,995.61
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Table.5: Solar system budget with trackers for average monthly production of 1500 kWh

SOLAR SYSTEM WITH MONTHLY	
PRODUCTION TRACKERS	1500 KWh / month
VALUE MATERIALS	R \$ 45928.88
FREIGHT AMOUNT	R \$ 2296.44
TOTAL	R \$ 48225.32

Table.6: Solar system budget with trackers for average monthly production of 3000 kWh

SOLAR SYSTEM WITH MONTHLY	
PRODUCTION TRACKERS	3000 KWh / month
VALUE MATERIALS	R \$ 91857.76
FREIGHT AMOUNT	R \$ 4592.88
TOTAL	R \$ 96450,64

V. CONCLUSION

According to the results of the cost estimates for the implementation of solar systems, to install in the city of Porto Nacional - TO, it can be observed that the values are different and despite the solar system with tracker, regardless of its type, to capture more energy due to the advantages of following the maximum solar luminosity, it is always important to see the economic viability of each citizen when choosing which system to use. The fixed system in the company in which the budget was made, already comes with the value of incuse labor, and this adds up in the choice of who chooses this type of system. Depending on how complex the system is, deployment costs are higher.

When it comes to the advantages and disadvantages of the fixed system and the system with trackers, it is possible to say that the fixed system has a lower cost when compared to the system with a tracker but in return, it captures less amount of sunlight to be converted into energy., since it is only in one direction. The system that has a tracker, has a higher cost due to the fact that it needs more software and equipment, but with that it can capture more heat stroke, because it can follow the direction of the sun.

Brazil receives a large amount of heat stroke per year. Only in the Northeast, the average daily solar incidence

varies between 4.5 to 6 KWh. Based on these data, it is possible to observe that Brazil has an abundant energy source, but ends up taking little advantage of this great potential and with unique characteristics that the country has.

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The fragile Sustainability of the Concept of Unsafe Act

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Keywords— *Work safety; accidents at
work; Unsafe Act; accident analysis,
sustainability.*

Abstract— *Beliefs regarding causes of accidents at work as “unsafe act” or “unsafe condition” have ruled the completion of work accident reports in a simplistic and inefficient way. It is noticed that the concept of blaming the worker prevails in most of the literature on work accidents. Besides, the same bias may be noticed in most company registers, which are usually filled by those in charge of analyzing and preparing reports of work accidents in the organization. The conclusion of making the victim of the work accident guilty, tends to misrepresent the fault of the company or those in charge. In the present article, 311 work accidents occurred in a company of the sugar and alcohol sector within a two years period were analyzed. The amount of 196 accidents characterized as “unsafe acts” was identified. The analysis was used using ABNT NBR ISO 31000 (2009) and which suggests the Root Cause Analysis tool, which aims to identify hidden causes in reported accidents. The theoretical framework for analysis was built from specific Brazilian legislation and technical standards. As a result, the disclosure of root causes of the accidents at work indicated that the “unsafe act” concept is fragile and inconsistent, which made it possible to de-characterize the original concept of “unsafe act” defined by the company.*

I. BIBLIOGRAPHIC REVIEW

It is noticed that the NBR 14280/2001 (ABNT, 2001), legitimizes the classification of accidents in "unsafe act and" unsafe condition ". From then on, it is possible to observe the creation of a paradigm, that an accident at work has only two causes, the “unsafe act” or the “unsafe condition”, consolidating the simplistic and inefficient way of concluding a report of an accident at work or not to go deeper into the studies of the real causes of accidents at work.

According to Chi et al. (2012), in the daily production process of companies, work safety is affected by a series of risk factors, one of which is described as human error (unsafe act). The same author states that such deviations are characterized as errors of judgment or improper operation. Castro and Okawa (2016), reaffirm this assumption when describing that the risky behaviors

that lead to the occurrence of the accident also lead to injury.

In an analysis of 104 reports, registered by the Criminal Institute of a city in the interior of São Paulo, which investigated the causes of accidents that occurred, 80.3% were attributed to "unsafe acts" and 19.7% to "unsafe conditions" (Vilela et al., 2004). In their study, Tong et al. (2018) analyzed a total of 225 accidents that occurred in coal mines and presented the interaction between the different dimensions of workers' unsafe behavior.

Such statements are consistent with that described in the work of Heinrich (1936), who presented the concept of “unsafe act” and indicated that this was the main cause of accidents at work and that they accounted for 88% of cases. Many other sources suggest that "unsafe acts", as a predominant way of addressing this issue, is to consider

the worker as a danger, a component of the system whose "unsafe acts" are implicated in most catastrophic failures (Reason, 2017).

Almost a century after Heinrich (1936) cited "unsafe acts" and advances in the field of accident analysis and prevention management, it is also noted that the concepts that hold workers responsible for the accidents of which they are victims are still maintained nowadays (Reason, 2017). Vilela (2004), adds by stating that the explanatory monocausal model centered on the victim's guilt has remained untouchable in the technical industrial environment, in the most conservative academic circles and in official bodies.

Such statement is ratified when the "social acceptability" of the accident analysis method is notorious, which is based on the opposition between "unsafe act and" "unsafe condition", technically legitimized by the Brazilian Association of Technical Standards (ABNT) when publishing the NBR 14280 standard / 2001 (ABNT, 2001), as explained by Jackson Filho et al. (2013). It is questioned here whether an accident is considered to be such a simple event to which only two causes can be attributed, the "unsafe act" or the "unsafe condition".

When evaluating different models of accident reports, the existence of the field "cause ascertained" is perceived, and the use of the singular in this denomination reveals the simplistic nature with which the accident is seen, and referring the researcher's option to choose between the "unsafe act" and the "unsafe condition", as explained by Vilela et al. (2004). The investigations of accidents that blame the victims and emphasize the responsibility of the worker under all circumstances, are adopted behind the scenes of companies (Reason, 2017).

One of the roots of blaming the victim for the accident is the lack of information or the imperfect training of professionals related to work safety (De Oliveira et al., 2007). Despite the scientific discredit of these conceptions, it is clear that it is rooted in the culture of prevention, a fact that is proven by the great use and acceptance by businessmen, professionals in the field, public agents, researchers and workers (Jackson Filho et al., 2013).

Vilela et al (2004) question whether the silent maintenance would not be a demonstration that this model would be convenient and interesting to hide the real causes of accidents at work. In the light of this thought, the blaming of workers who are victims of accidents describes an efficient mechanism for making engineers and safety professionals not responsible, as well as management and the public companies or institutions involved in the misfortune (Jackson Filho et al., 2013).

Accidents do not happen, but are caused by design errors due to lack of management and planning. Reason (2017), classifies two conceptions of accidents as being "engineering" and "organizational". The first refers to intrinsic prevention actions, such as planning, quantifying events or associated aspects of occupational health and safety management systems and improvement in the work environment.

In the light of Law No. 6,514 / 77 (BRASIL, 2019a), in its article 157, it describes that it is up to companies:

"II - Instruct employees, through work orders, as to the precautions to be taken in order to avoid accidents at work or occupational diseases."

In this item of the law, it can be questioned whether all workers are really informed about the risks, whether they receive the necessary training, whether all tasks are demanded by order of service, whether the task was planned under the perspective of existing risks and for finally, if this task was analyzed using any risk management technique, aiming at anticipating it and mitigating such risks.

It is clear that it is the company's obligation to instruct employees, through service orders, to take precautions to avoid the accident. The company must make an assessment of the activity foreseeing such risks, and this can be done by risk management techniques, such as Preliminary Risk Analysis, Hazop, Failure and Effects Analysis or any other technique that anticipates and mitigates the risk accidents or occupational diseases.

Regarding risk assessment, Namian et al. (2018) in their studies revealed that workers are unable to identify a large proportion of risks in their workplaces. From this perspective, it can be questioned whether it is really correct to attribute to the worker the function of assessing all the risks present in their work tasks.

Regarding the organizational concept, Law No. 6,514 / 77 (BRASIL, 2019a) describes:

"Art. . 157 - It is up to the companies:

I - Comply with and enforce safety and occupational medicine standards".

In this context, "comply" refers to the obligation to comply with laws. And with an emphasis on "enforcing", which refers to the thought that companies have a preventive management system and that does not allow any eventual deviation from the procedures, so it must provide actions or devices that curb this eventual deviation.

It can be exemplified as a deviation the fact that the employee, even if instructed, does not use personal protective equipment. However, this deviation cannot be considered as an “unsafe act”, as the company fails to “enforce” by demonstrating a weakness in its management system, by failing to inspect, raise awareness and provide really concrete actions in favor of this management of prevention. The term “enforce” suggests thoughts related to the commitment and obligation of companies in preventive management.

Another relevant aspect, which is the right and obligation of the company, is to punish an employee who, without justification, refuses to comply with the aforementioned service orders or company security procedures, as stated in article 158 of the Consolidation of Labor Laws (Brasil, 2019b) and such omission on the part of the company is evidenced as a management failure.

According to Zhang et al. (2019), that safety leadership and group-level organizational climate had a significant effect on workers' behavioral performance. These elements contribute to confirm that the influences of the leadership contribute to the management of accident prevention, and can contribute positively or negatively.

This element alone, when negative, is considered to be an “unsafe condition”. Returning to the example, that when a worker stops using individual safety equipment, and this event cannot be considered as an “unsafe act” because it refers to a weakening of his management system, to the extent that he does not exercise his punishment obligation.

It is emphasized here that the responsibility for occupational safety management is not the sole responsibility of the occupational safety engineers and technicians, as shown by the studies by Zhang et al. (2019), who states that the following actors were considered influential in the performance of occupational safety: safety professionals (safety engineers and occupational safety technicians), professionals in the project area, as stated by Geminiani et al. (2013) and operation.

It should be noted here that in terms of responsibility, leaders (managers, supervisors, coordinators, among others) are primarily responsible for ensuring that procedures related to work safety are complied with, and not work safety professionals, as this has the development function, not policing. Jackson Filho et al. (2013), explain that “blame attribution” allows most organizations to solve their own organizational problems.

Vilela (2004) highlights the fact that the legal theory about accidents at work is based on subjective responsibility, based on the need to show the employer's

guilt to support civil and criminal processes. In the Brazilian Civil and Penal Codes, they state that there is no civil reparation or criminal prosecution when the accident occurred "due to the victim's exclusive fault".

Jackson Filho et al. (2013), that accident analysis is always influenced by the analyst's view or understanding of these events. It should be noted that the occupational safety manager is responsible for developing the company's safety procedures and will also be responsible for analyzing the accident. The values implicit in a given conception are not always clearly assumed or understood by that same analyst, as explained by Vilela et al. (2007).

When stating that analysts are the professionals responsible for promoting occupational safety (engineers and safety professionals), the attribution of blame to workers who are victims of accidents is typically a mechanism to make these professionals, as well as the management and the companies themselves, responsible.

From the above, it is evident that the fact that whoever is responsible for the elaboration of procedures related to work safety will be responsible for the investigation of the accident and, in this situation, he would have as an option the characterization of the “unsafe condition” exposing the weaknesses of the organizational systems and engineering that is responsible for characterizing it as an “unsafe act” when attributing the blame to the victim.

Jackson Filho et al. (2013) present an idea launched at the Work Accident, Analysis, Prevention and Associated Aspects Forum, in 2013, by the Universidade Estadual Paulista - Unesp, through its coordinating group, which proposed a public manifest aimed at banning accident analysis methods based on unsafe acts, which lead to the blaming of workers, victims of accidents.

Llory and Montmayel (2010) corroborate these thoughts when they affirm that, from a scientific point of view and, in particular, from the state of the art of research in the field of analysis of catastrophes and accidents at work, the persistence of the use of the notion of unsafe act it is unacceptable. De Oliveira et al, (2007), suggest that the lack of information or imperfect training of professionals related to work safety, has contributed to aggravate this problem.

As a way of mitigating this situation, that is, imperfect training of professionals, many quality management tools are presented to contribute to the solution of this impasse. Explain Neto et al. (2019), that the great acceptance of the market for these tools, expanded the approach to many other sectors, where it mentions the protection to the environment and the safety and health of the worker.

Corroborating this thought, Kuendee (2017) reports that quality tools can be used in any activity of the institution. Ratifying the same premise, claim Da Costa Almeida et al. (2019), that quality tools can work in conjunction with process management techniques in addition to the management of support areas. As a benefit, the use of these tools ensures the integration of several systems within the organization (Neto et al., 2019).

The ISO 31000 is a standard in the risk management family created by the International Organization for Standardization. The purpose of this standard is to establish general principles and guidelines on risk management. ISO 3100 consists of three standards:

- a) ISO 31000 - Basic information, principles and guidelines for the implementation of risk management.
- b) ISO / IEC 31010 - Risk assessment and management techniques.
- c) ISO Guide 73 - Vocabulary related to risk management.

ISO / IEC 31010 is a standard created by the International Organization for Standardization (ISO) in partnership with the International Electrotechnical Commission (IEC). which was translated by ABNT as "NBR ISO 31010: Risk management: Techniques for the risk assessment process". This is not a standard for certification, but for supporting ISO 31000, bringing tools for carrying out risk assessments (De Oliveira et al., 2017). This standard presents 31 tools, including the Root Cause Analysis (RCA) tool, also known in Quality Management as "5 why".

RCA consists of a technique capable of identifying the main causes for a given problem, which avoids an unnecessary focus on solving its "symptoms", to the detriment of its cause, as explained by Da Costa Almeida et al. (2019).

Regarding the execution of the technique, Aguiar (2014) suggests that the first "why" should be elaborated based on the cause raised, answering the reason for the problem's occurrence. The second, on the other hand, must be applied based on the answer of the first "why" and so on, until the main cause of the problem is raised.

In the context presented so far, an analysis of an accident history of a company in the sugar and alcohol sector will be carried out. In this, the accidents that were observed by the company representative will be investigated, where they were characterized as an "unsafe act". For this, a technique called RCA will be applied, as a tool to determine the causes of the unwanted event.

II. METHODOLOGY

A company in the sugar and alcohol sector (company will not be identified), made available a report of accidents that occurred between the period of 2017 and 2018 (two years) and a description of 311 accidents. This report presented the causes attributed by the company's representatives, classified as "unsafe act" and "unsafe condition". With the descriptions and details of the events that obtained the classification "unsafe act", the RCA technique was applied.

In Tables 1 to 3, in the "Accident Description", the description of the accident given by the company's representatives is presented. The application of the RCA tool is also presented, where it was directed to the identification of root causes of the accident. In the "legal analysis" section, a framework was sought to legitimize or reclassify the concept attributed by the company's representatives. Finally, in the section "Risks Identified by the RCA Methodology", the causes of the accident are presented, identified by the application of the tool.

The results of the analyzes were compared and discussed from the point of view of whether the classifications defined as "unsafe acts" were applied correctly, that is, if there was no evidence of failure on the part of the company, thus configuring an "unsafe condition".

III. RESULTS AND DISCUSSION

Figure 1 shows the classification (in percentage), of the causes of accidents at work, extracted from the reports, in which 311 accidents belonging to the groups of accidents with and without lost time, accidents with and without victims and with material damage were totaled. . Of this total, 196 accidents (63%) were classified by the analyst as "unsafe acts" and the remainder as "unsafe condition".

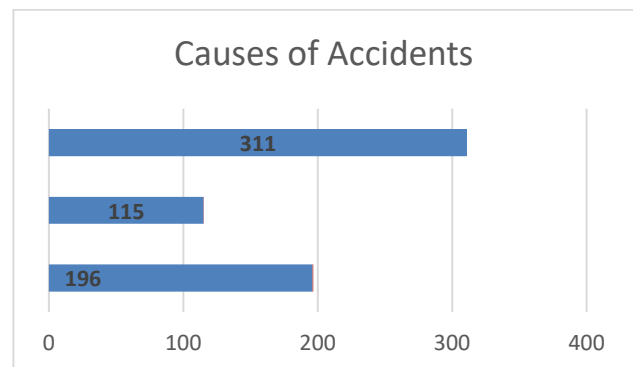


Fig.1: Causes of accidents

After analyzing the 196 accidents reported as “unsafe acts”, using the RCA technique, we sought to identify the root causes to justify what happened. Due to the large volume of information, only three analyzes were presented in this text.

In Tables 1 to 3, the investigations of the event carried out by the company representative were presented in the “accident description” field. In the “Why's” fields, the methodology is applied, in which it seeks to identify the cause (risks) hidden in the “description of the accident”. In the “legal analysis” fields, searches were made in the laws and technical standards, with the aim of identifying whether the classification carried out by the company (unsafe act) is correct.

Finally, in the fields “Risks Identified by Methodology”, some risks presented by the authors of this article are presented. After analyzing the 196 accidents reported as “unsafe acts”, using the RCA technique, it was found that in their entirety, legal bases were found in the legislation and technical standards that mischaracterize the concept of “unsafe act”.

In Table 1, during the evaluation of the accident that occurred (carried out by the company's representative), the type of accident was classified as an “unsafe act” because the maintainers started work with the pressurized equipment. It is evident, in this case, that the company does not comply with NR12 when it did not foresee in its project the installation of a pressure relief valve or any other device that ensures the maintenance of the equipment safely.

The fact that the workers started the procedure with high-calorie equipment is still under discussion, but the pressure for better work efficiencies in fulfilling numerous tasks during their workday was ignored. Would management accept the fact that the equipment would be idle for hours waiting for maintenance actions while it cooled down?

Ratifying the thinking of Zhang et al. (2019), that leaders can contribute positively or negatively. This element alone, when negative, is considered to be an “unsafe condition”. Another fact, presented in Table 1, is about the early risk assessment before the intervention of the equipment that did not occur.

Noncompliance with the legislation is also present in the analysis of Table 2, where ergonomic aspects and safe access to the equipment were not appreciated in the design and installation phases. It is evident that it is normal for employees to perform tasks in a way that requires more comfort and less fatigue, and such needs must be part of a risk analysis in the installation and design of equipment and, also, for the release of the task in the operation.

The opening and closing of valves can be motorized or automated, providing more safety and comfort to operators. As explained by Zhang et al. (2019) and Geminiani et al. (2013), there is a significant influence of sectors in the project area on the performance of work safety.

In Table 3, in the description of the accident, it was stated that the employee did not pay attention when allowing the truck to leave after the cane was unloaded, as it would be usual for him to authorize the movement only when the other collaborators finished executing the task of uncoupling the truck. vehicle body.

Factors such as low-light night work (due to lack of maintenance) were evident, demonstrating the failure in the company's operational management to not guarantee the best working conditions. In terms of character, the confusion of characters and considering that all workers are in uniform, added to the low light of the place, required greater attention from the employee in carrying out the task. This confusion can also be attributed to a management failure, as these adverse conditions should be foreseen.

When analyzing NR 12, in that risk area, there should be a limitation in the traffic of people, in addition to guaranteeing those involved in the task visibility to ensure safe maneuvers, and these aspects were not observed by the company. As evidenced by Jackson Filho et al. (2013), points out that it is the company's role in developing safe operating procedures.

As a solution to this impasse, the use of stop and emergency buttons to be activated by employees G1 and G2, as provided for in NR 12 in its item 12.24, which determines that “The devices for starting, starting and stopping the machines must be designed” would resolve this issue, that is, the company did not meet NR 12.

According to Zhang et al. (2019), leadership in the company has a significant effect on the workers' behavioral performance and this fact was evident in situations in which the omission or lack of leadership allowed to make decisions that led to the occurrence of negative events. Defining the responsibilities of their subordinates, defining rules to be followed and using their authority to punish when necessary, are the attributions of leaders that converge in results in favor of accident mitigation.

The analysis also presented evidence in all situations that there was a failure on the part of accident reporters to not know or omit the current legislation, a fact that contributes to conceal the true causes of accidents at work, and does not hold engineers and professionals responsible security, as well as the management and the

companies or public institutions themselves involved in the misfortune, as exposed by Filgueiras et al. (2012); Jackson Filho et al. (2013) and Vilela (2004).

Regarding the RCA tool, it proved to be an option for application in accident assessment reports, as it deepens the analysis and presents the hidden causes and as suggested by Neto et al. (2019), Kuendee (2017) Da Costa Almeida et al. (2019).

IV. CONCLUSION

In light of the discussion of the concept of “unsafe act”, and corroborating with Jackson Filho et al. (2013), Vilela et al (2004), Reason (2017), Llory and Montmayel (2010), “blaming” allows most organizations to solve their own organizational problems. According to the results of the analysis, the accidents presented that received an initial classification given by the company's representative, as an “unsafe act” are easily uncharacterized by the content present in the laws and regulations. In addition, it demonstrates that companies rely on Brazilian legislation and use it to avoid civil reparation or criminal proceedings when the accident occurred “due to the victim alone.”

In another point of view, such failures of analysis, have a contribution of the fact that, the authors of the safety procedures are the same ones that evaluate the cause of the accident. In other words, they are given the choice between defining it as an “unsafe condition”, which refers to a weakness of these procedures and other aspects of management or the option to classify it as an “unsafe act” and to blame the victim, who is the most weak of this unfair condition. Paralleling the three powers, executive, legislative and judicial, proposed by Montesquieu and adopted by the Brazilian constitution, where the essence of this theory is based on the idea that these powers act separately and are supervised. When companies design procedures, conduct operational management, analyze, judge the causes of accidents and ultimately blame them, they would be playing the role of the executive, the legislature and the judiciary. And the result of this is the exacerbation of power and the ability to impose the truth itself.

In another reflection, the one who is responsible for the development of safe procedures, when in a simplistic way, has as a legal alibi, accusing the victim of the accident, will not have the need for his personal development, technically or morally, in his noble attribution of accident prevention. In this context, the results of the professionals are measured by the numbers of accidents. According to MTE statistics, these results have long been subject to no reduction (ANPT, 2019), and

demonstrate the low evolution in accident prevention practices.

Finally, attributing to an accident only the causes “unsafe act” and “unsafe condition” is an inefficient way to complete an accident analysis, as it has, as its sole purpose, “finding a culprit”. Such a form of analysis does not point to any risk, and also does nothing to prevent such an accident from recurring or the identification of other potential risks. Regarding the “5 whys” tool, it presents itself as an easy-to-use methodology that can be useful for identifying risks in the analysis of accidents that have occurred.

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Table 1: Analysis of the accident 147.

Description of the Accident: Two mechanics were carrying out maintenance on the decanter 3 pipe, they started the intervention on the pipe, however when the racket was removed from the pipe, it was still with steam and hot broth and this due to the pressure of the line was against employees. One of the employees involved was hit in the neck by the hot broth causing a slight burn, the other employee not to be reached jumped in the direction of another nearby tank and when he fell he stepped on the wrong causing a slight injury.
Observation obtained in the accident registration worksheet: Pointed out as an unsafe act due to the fact that they could not have started maintenance with the equipment above room temperature.
1st Why: Why was there an injury? The tubing was disassembled while still pressurized and with heated liquid.
2nd Why: Why was the pipeline pressurized and with heated liquid? As the equipment (decanter) was in operation, the only way to depressurize was to loosen the racket from the pipe.
3rd Why: Why was it the only form of depressurization? There was no depressurization system installed, like a relief valve.
4th Why: Why was there no relief valve installed? It was not foreseen in the project.
5th Why: Why was it not foreseen in the project? There was no request for such a device by the company.
Legal Analysis: According to NR 12 (NR12, 2019), in item 12.77: Additional measures must be adopted to protect hoses, pipes and other pressurized components subject to possible mechanical impacts and other aggressive agents, when there is a risk.
Risks Identified by the RCA Methodology: 1- Lack of safety device (relief valve).

2- Lack of detail and requirements related to work safety, by the project sector when purchasing equipment

Table 2: Analysis of the accident 151.

Description of the Accident: Due to the vinasse booster pump having a problem and the other without a motor, the employee went to turn on the 3rd backup pump and open the valve, it was very dark and he stepped on the wrong side when he climbed over the pipe fall on the channel. It was full of hot vinasse.
Observation obtained in the accident registration worksheet: Pointed out as an unsafe act due to the fact that it could not have climbed in the pipeline to open the valve.
1st Why: Why was there an injury? Due to the fall of the employee who climbed the pipe.
2nd Why: Why was there a fall? Why did he climb the pipe.
3rd Why: Why did he climb the pipe? Because there was no access or platform to perform the operation.
4th Why: Why was there no platform for the operation? It was not foreseen in the project
5th Why: Why was it not foreseen in the project? There was no request for such a device by the company.
Legal Analysis: 1- According to NR 12 (NR12, 2019), in its item 12.64): Machines and equipment must have permanently fixed and safe accesses to all its points of operation, supply, insertion of raw materials and removal of processed products, preparation, maintenance and constant intervention. 2- According to NR 12 (NR12, 2019), in its item 12.94, it defines in its paragraphs "f", "g" and "h": f) favoring the performance and reliability of operations, with a reduction in the probability of failures in the operation; g) reduction in the demand for strength, pressure, gripping, flexing, extension or twisting of the body segments; h) the lighting must be adequate and available in emergency situations, when entrance is required.

Risks Identified by the RCA Methodology:

- 1- Lack of secure access.
- 2- Lack of ergonomic design
- 3- Lack of lighting.

Table 3: Analysis of the accident 4.

Accident Description: Employees G1, G2 and G3 performed the operation of coupling and uncoupling the steel cables that have the function of tilting the body of the cane truck. After unloading the cargo, operators G1e G2 unhooked the hooks of the steel cables from the rings of the trucks. In a given situation, operator G3 gave the signal for the truck to be released and the truck started moving. However, the task had not yet been completed by the collaborator G1, who was still removing the ring from the truck when it loosened, hitting his face (injuries to his face and broken teeth).
Observation obtained in the accident registration worksheet: In the accident registration, the operator G3 was pointed out, who was not aware of the operations of the G1 and G2 employees. According to the G3, he informed that he was mistaken when he confused the G1 with another collaborator of the plant (who did not work in that sector) and that he was at the site, also arguing that, as it was night he had difficulty in recognizing.
1st Why: Why was there an injury? G3 authorized the truck to move without the task having been completed.
2nd Why: Why did G3 authorize the truck to move without the task having been completed? Believing that the employee he had seen outside the risk area was G1.
3rd Why: Why was there a confusion of characters? a) Why a fourth employee of the company was in the place that would normally be the G1. b) Why the lack of light contributed to the confusion of characters.
4th Why: Why was this fourth character in that location? There was no restriction on staying there. Why was the place in low light? Why the fixtures lacked maintenance.
5th Why: Why was there no restriction if it is a risk area? Lack of operational management. What is the reason for the lack of maintenance? Lack of operational management

Legal Analysis:

1- According to NR 12 (NR12, 2019), in its item 12.8.2, circulation areas and spaces around machines must be designed, dimensioned and maintained so that workers can move safely. Thus, a controlled or isolated area should be provided that would not allow the movement of strangers to function.

2- According to NR 12 (NR12, 2019), in its item 12.95, “The controls of the machines and equipment must be designed, built and maintained in compliance with the following aspects: ... c) visibility, identification and signaling that allows them to be distinguishable from each other; ... e) guarantee of safe maneuvers in order to avoid involuntary movements”.

Risks Identified by the RCA Methodology:

- 1- Mechanisms that prevent involuntary actions of starting machines
- 2- Analysis and adequacy of NR 12
- 3- Neglect of the sector leadership regarding the aspects of maintenance and operation management

Relation between Age and Body Composition of Institutionalized Fragiles Elderly Women

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Keywords— accident analysis, sustainability, Frailty, Geriatric Assessment, Health of the institutionalized elderly.

Abstract— In the last decades, due to the reduction of mortality rates and the fall of birth rates, there has been a transformation in Brazil's demographic profile, which has increased longevity, and consequently, in the expressive number of elderly people. With the life expectancy's increase, functional alterations arise that can compromise the functional independence and quality of life of this population. Among the most relevant aging-related alterations is the Frailty Syndrome of the Elderly (FFS). This syndrome is considered highly prevalent, resulting in dramatic consequences to the health of the elderly. North American data show a prevalence of 7 to 12%, and in Latin America and some Caribbean countries, the prevalence has increased considerably, being 30 to 48% in women and 21 to 35% in men. These rates far exceed not only North American data but also data from European countries. **OBJECTIVE:** To analyze the relation between age and body composition of institutionalized fragiles elderly women. **METHODOLOGY:** Forty elderly women, aged ≥ 70 years, diagnosed with SFI without dementia and/or depressive features were selected. After body mass index (BMI) determination, classification into three groups was performed ($n=6$ underweight <22 kg/m², $n=13$ eutrophic 22 to 27 kg/m², and $n=21$ overweight >27 kg/m²), total muscle mass index (TMSI) by predictive equation, and handgrip strength (HGS) by dynamometry were also evaluated. **RESULTS:** Significant differences were found in the means of BMI (underweight 20.1; eutrophic 25.2 and overweight 30.5; $p<0.000$) and IMMT (underweight 4.9; eutrophic 6.3 and overweight 7.8; $p<0.000$). Both indices decreased with advancing age. The mean IMMT was lower than normative values (5.9 to 9.5 kg.m-2) only in the low weight group. Although no significant differences were found

between the groups in the FPM measurements (underweight 17.2; eutrophic 16.2, and overweight 18.6), the overweight group performed better. CONCLUSION: The results show that as age advances there is a reduction in BMI and IMMT. Although the group with the best muscle strength measurements was the overweight group, this was the youngest group. However, it is worth remembering that these findings may corroborate the Obesity-Mortality Paradox, where body weight, although above the reference values for the elderly (between 22 and 27 kg/m²) could manifest itself as a protective factor for the elderly, thus representing an energy reserve that could be used when facing pathological conditions such as malnutrition or infections. The importance of a thorough evaluation of body composition, nutritional status, and muscle strength in the elderly is emphasized, and it is also suggested that bodyweight should be maintained at least at levels close to normal.

I. INTRODUCTION

According to Meneguci, Santos, and Damião (2014), the demographic transition is a reality in both developed and developing countries, such as Brazil, being represented by the significant increase in the elderly population accompanied by higher life expectancy each year. Estimates suggest that, currently, approximately 10% (705 million) of the world population is represented by the elderly, and that in 2050, this prevalence will reach 32% (2 billion) (FREITAS et al., 2015).

According to Falsarella (2015), aging is a continuous and gradual process, as well as heterogeneous among populations, since it is influenced by the environment, culture, genetics, and presence or absence of pathological conditions. From the biological point of view, aging is characterized by the decreased ability of body systems to maintain homeostatic balance under conditions of functional overload, leading to greater vulnerability. In this sense, changes in the physical, cognitive, and social dimensions in the elderly population contribute to the increased risk of adverse health manifestations.

In the elderly, global functionality, i.e., the individual's ability to manage their own life or take care of themselves, is an important predictor of health, since it considers the dynamic and integrated functioning between the environment, cognition, and motor skills. From this perspective, investigations of the variables associated with aging, such as body composition, are relevant in geriatrics and gerontology today, since changes in body composition, with advancing age, have an important impact on health status, functional capacity, and quality of life (FALSARELLA, 2015).

The changes in body composition are inherent to the physiology of aging and are due to the reduction of lean mass, especially muscle mass and bone mineral density, the decrease in height, weight changes, the redistribution

of adipose tissue, with greater accumulation in the trunk and viscera and less in the limbs, and changes in tissue compressibility and elasticity. In women, for example, the increase in body mass reaches its plateau at age 75, when it begins to decline associated with the reduction of body water and muscle mass (TAVARES et al., 2015; SILVA; PEDRAZA; MENEZES, 2015).

However, such changes in body composition can contribute to unfavorable outcomes for mobility, such as falls, fractures, limitation in self-care tasks, and independent living, as well as representing a predictor for Elderly Frailty Syndrome (EFS), comorbidities, and mortality (FALSARELLA, 2015).

Likely, changes in the lifestyle of the world population that has occurred in recent decades, such as the change in dietary profile, physical inactivity, and smoking have determined the phenomenon of epidemiological transition, characterized by a reduction in mortality from infectious diseases, however, with an increase in chronic non-communicable diseases (NCDs) that are based on overweight (CARLOS; GAZZOLA; GOMES, 2016; MENEGUCI; SANTOS; DAMIÃO, 2014).

According to Costa and Neri (2011), in addition to the progressive functional impairment resulting from the clinical manifestations of NCDs inherent to aging, we should also consider the increased prevalence of IFC, resulting in dramatic consequences to the health of the elderly. North American data point to a prevalence of 7 to 12%, while in Latin America and some Caribbean countries the prevalence has increased considerably, being 30 to 48% in women and 21 to 35% in men. These rates far exceed, not only North American data but also European countries (XUE, 2011).

According to Pereira, Spyrides, and Andrade (2016) and Soares et al. (2016) this context of aging and prevalence of NCDs and IFC in this age group require

from the authorities and researchers in the area special attention regarding the epidemiological and clinical aspects of this group of people.

Based on this reasoning, this study aimed to analyze the relationship between age and body composition of institutionalized frail elderly women.

II. METHODOLOGY

This is a descriptive study developed in the long-stay institutions (ILPs) Bethesda and Betânia, in Joinville, Santa Catarina, Brazil. The research project was approved by the Ethics Committee for Research in Human Beings of the Instituto Superior e Centro Educacional Luterano Bom Jesus/IELUSC under number 393.274. To participate in the study, the elderly women signed a Free and Informed Consent Form (FICF).

Study Participants

From a total of 140 elderly residents in the two largest ILPs in the city of Joinville-SC (Bethesda and Betânia), 45 intentionally selected elderly women aged ≥ 70 years were evaluated. This process occurred after an initial screening by the health teams of the institutions. Five participants were not part of the study according to exclusion criteria (two with dementia traits, two with impairments secondary to stroke, and one parkinsonian). Thus, 40 women diagnosed with IFC, presenting frailty characteristics according to the criteria already established (FRIED et al, 2001), participated in the study. They did not present cognitive deficit or depressive traits, evaluated by the Mini Mental State Examination and the Geriatric Depression Scale, respectively. All had lived in the institutions for at least three years, received the same nutritional orientation and general health care, such as regular use of medication and monitoring of vital signs, and were independent in their activities of daily living.

Measurement Instruments and Evaluation Procedures

The evaluations were initiated through a registration form containing personal identification data, a brief anamnesis, and a list of twelve pathologies and/or associated dysfunctions (systemic arterial hypertension, diabetes mellitus, stroke, parkinsonism, cardiopathy, pneumopathy, nephropathy, obesity, rheumatic disease, visual, auditory and/or vestibular deficits), medications in use and associated treatments. As initial screening instruments, the Mini Mental State Examination was used, considering cut-off scores according to the level of education (WAJMAN et al, 2014; BRUCKI et al, 2003) and the Geriatric Depression Scale to screen the elderly with a depressive profile (VALIM-ROGATTO et al, 2011).

To classify the level of physical activity (low, moderate, and high) the International Physical Activity Questionnaire - Short Form was used (VALIM-ROGATTO et al, 2011).

Muscle strength was evaluated through dynamometry. A TAKEI® handgrip dynamometer was used to assess handgrip strength. The evaluation of handgrip strength was measured according to the recommendations of the American Association of Hand Therapists (SOARES et al, 2012). The equipment was calibrated before data collection. After performing two measurements of maximum isometric contraction (3 to 5 seconds) the best measurement was recorded.

For muscle mass evaluation a predictive equation was used (LEE et al, 2000) establishing the Total Muscle Mass Index (IMMT) ranging from 5.9 to 9.5 kg.m⁻², calculated by the formula below. Where the Total Muscle Mass Index is expressed by IMMT (kg.m⁻²) = MMT / E².

$$\begin{aligned} \text{Massa Muscular Total (MMT)} \\ = 0,244.PC + 7,80.E1 - 0,098.I \\ + 6,6.S + Et - 3,3 \end{aligned}$$

Where BW = body weight, in kg; E1 = height, in meters; I = age, in years; S = gender (female = 0 and male = 1; Et = ethnicity (Caucasian = 0, Asian = -1.2; Afro-descendant = 1.4).

A digital scale with a 50g resolution was also used to measure body mass (Model 2096PP, Toledo®, BR), a stadiometer with a 1mm resolution to measure the height (Model ES2020, Manufacturer American Medical do Brasil Ltda, Sanny®, BR).

After determining the Body Mass Index (BMI), the elderly women were classified into three groups: Low weight <22 kg/m²; Eutrophic 22 to 27 kg/m²; and Overweight >27 kg/m². This classification of nutritional status based on BMI was proposed by the *Nutrition Screening Initiative*, considering the changes in body composition inherent to aging. These cut-points were adopted for the elderly in Brazil according to recommendations of the Food and Nutritional Surveillance System (SISVAN). This classification seems to be more appropriate for the elderly population than the classic general classification recommended by the WHO (PEREIRA et al, 2016).

III. DATA ANALYSIS

The tabulation and analysis of data were performed in GraphPad Prism 6® software. Descriptive statistical data were obtained as means and standard deviations. To verify the differences between the groups classified by BMI the *Student's t* test was applied with a significance level of 95% (p<0.05). To verify the

relationship between age and the other study variables the Pearson Correlation Test was used, with a 95% significance level ($p < 0.05$).

Table 1. Summary of the results of the three groups classified according to BMI

	BMI <22		BMI 22 to 27		BMI >27
	n=6	p-value	n=13	p-value	n=21
Age	87,5 (4,8)	0,476	85,4 (7,7)	0,213	82,2 (5,5)
MEEM	27,3 (3,7)	0,164	24,5 (4,0)	0,899	24,7 (3,6)
BMI	20,1 (0,8)	0,000*	25,2 (1,7)	0,000*	30,5 (2,5)
IMMT	4,9 (0,4)	0,000*	6,3 (0,6)	0,000*	7,8 (0,9)
FPM	17,2 (4,9)	0,684	16,2 (5,0)	0,194	18,6 (5,5)

BMI, Body Mass Index (kg/m²); **Age**, in years; **MMSE**, Mini Mental State Examination (0-30); **TMSI**, Total Muscle Mass Index (5.9 to 9.5 kg.m-2); **FPM**, handgrip strength (kgf, women >16). All variables present mean **M** and standard deviation (**SD**). significant difference ($p < 0.05$).

The first interesting aspect to be observed in Table 1 is that the BMI decreases as age advances, although the age difference between the groups was not significant, this fact draws attention. However, it can be seen that the groups have a significant difference in mean BMI and MFI. Of the 40 women participating in the study, most are overweight (52.5%), and as for the MFI, only the underweight group (MFI 4.9 kg.m-2) had rates below the normative values (5.9 to 9.5 kg.m-2). The best FPM averages are from the overweight group, being 8.1% higher than the underweight group and 14.8% higher than the eutrophic group.

In this study, besides the classification of the elderly women into groups based on BMI, a correlation analysis between age and the other controlled variables was also performed. This analysis is of the group as a whole, since there is a lot of discrepancy between the number of participants in each group, and this hinders the individual correlation analysis of the groups. The data obtained are shown in Table 2.

Table 2. Correlation analysis of Age versus other variables

	MEEM	BMI	IMMT	FPM
Value r	-0,08	-0,40	-0,52	-0,14
p-value	0,626	0,010*	0,001*	0,376

MMSE, Mini-Mental State Examination (0-30); **BMI**, Body Mass Index (kg/m²); **TMSI**, Total Muscle Mass Index (5.9 to 9.5 kg.m-2); **FPM**, handgrip strength (kgf). * Significant correlation coefficients ($p < 0.05$).

Table 2 shows that there was a moderate negative correlation of age with BMI and IMMT, that is, as age advances there is a reduction of both indexes. There was also a very strong positive correlation between BMI and IMMT ($r = 0.89$ $p < 0.000$), showing that the higher the BMI, the higher the IMMT. At least in part, this can be explained because the IMMT obtained by the predictive equation adopted in this study uses the BMI value among the calculation variables.

As for the cognitive aspect assessed by the MMSE and the muscle strength assessed by the FPM, no significant correlations of age with these variables were observed.

IV. DISCUSSION

It is known that aging can alter body composition. What causes controversy is to unveil which changes may bring damages to the health of the elderly. The progressive loss of muscle mass and strength, and the redistribution of body fat with greater accumulation in the abdominal region are some of these changes that can compromise mobility, the performance of daily activities, increase the risk of falls, and generate progressive functional disability (FALSARELLA, 2015).

Following Carneiro et al. (2017) the BMI reduction related to advancing age, demonstrated earlier in our results, predominates in the longevous elderly and has a high relationship with frailty. Volpini and Frangella (2013) emphasize that women have a greater predisposition to the development of frailty when compared to men, since they have a longer life expectancy, and thus become more susceptible over time to the cumulative deleterious effects of chronic-degenerative diseases.

It is noteworthy that BMI is an important routine measure to detect the degree of malnutrition and assess body composition. Our findings showed a predominance of overweight elderly women. The deposition of fat mass in women occurs later, after menopause, mainly due to the drop in estrogen levels causing an accumulation of fat that ends up reflecting in BMI values (PEREIRA; SPYRIDES; ANDRADE, 2016).

Although the mean age was high, i.e., of older women (over 75 years old), the results of the present study showed that those with overweight had the lowest mean age. Such finding is corroborated by the study of Oliveira, Duarte, and Reis (2016) who showed that as age advances BMI values tend to reduce. According to Pereira, Spyrides, and Andrade (2016), there is a significant reduction in BMI with advancing age and this is explained by physiological changes resulting from aging. Essentially, reduced sense of smell and vision, diminished taste buds, chewing difficulties, use of ill-fitting dental prostheses, are factors that contribute to malnutrition in the elderly. Morphological changes of the stomach and difficulties in absorbing nutrients, as well as the slowing of gastric emptying with a consequent increase in satiety time, are additional factors to develop malnutrition (VIEIRA et al., 2015).

Another relevant aspect that characterizes frailty as a multidimensional phenomenon is the significant reduction in the level of physical activity, a common characteristic in the elderly, especially the institutionalized ones, accelerating the development of sarcopenia and dinapenia (VOLPINI; FRANGELLA, 2013). The loss of muscle mass is more pronounced in sedentary individuals, with a reduction of up to 50%. Usually, this change is accompanied by the transformation in body composition, where muscle mass is replaced by fat mass (TELMA, 2017).

Advancing age also dramatically affects muscle strength levels. There is a relationship between the loss of muscle mass and reduced muscle strength (SOARES et al., 2017). Such negative effects on muscle mass and strength are, at least in part, explained by the drop in hormonal

levels, and also by neural factors such as the degeneration of motor units (VIEIRA et al., 2015). To assess this physical valence, muscle strength, handgrip dynamometry is commonly used. This measure reflects the patient's overall strength because it has a good correlation with large body muscle groups (SOARES et al, 2017). As found in our study, the elderly women with higher BMI measures performed better in the strength tests assessed by dynamometry. Such findings are corroborated by other studies that found in underweight/undernourished elderly women a worse performance in muscle strength tests (SILVA et al, 2015).

V. CONCLUDING REMARKS

It seems quite evident that marked changes occur in body composition as a result of advancing age. Such changes are related especially to nutritional conditions and the reduced level of physical activity of the elderly. Thus, it should be remembered that a thorough assessment of body composition and muscle strength should be performed in clinical practice.

We can suggest that the maintenance of body weight at levels close to normal, as well as the maintenance of muscle strength, can be achieved with the control of chronic degenerative diseases, a good diet, and regular physical activity. Such recommendations should guide the management of the elderly, both in the prevention and in the possible reversal of signs and symptoms of the frailty syndrome.

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Evaluation of biometric parameters in the selection of substrates for buriti seedlings (*Mauritia flexuosa* L. f.)

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Keywords— Cerrado, Biome, Brazil,
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Abstract— The buriti (*Mauritia flexuosa* L.f.) is a tree species native of the Cerrado with food and medicinal importance in several places as well as for the population of western Bahia. In the west of Bahia, buriti oil is sold in open markets and the fruits are important in the region's culinary and medicinal uses and for that reason it is important to select substrates that guarantee the development of healthy seedlings, aiming at a high survival rate in the field. The objective of this work was to identify suitable substrates for the development of buriti seedlings. The experimental design was a randomized block with ten treatments and four replications. The substrates used were sand, wood shavings, sugarcane bagasse, soil, cattle manure and footpath soil. The conclusion was that the footpath soil was the one (100%) that provided the best development of the buriti seedlings, which is the most recommended for a quick nursery production. However, given the difficulty of obtaining this material, sand (80%) + soil (20%) can be used to replace footpath soil with similar results.

I. INTRODUCTION

The species *Mauritia flexuosa* L.f. popularly known as buriti, belongs to the family Arecaceae. The buriti palm occurs in flooded areas, forming dense populations in areas of footpaths (Martins, 2012). It is a palm tree that deserves to be highlighted for its abundance in Brazilian flora (Rossi *et al.*, 2014).

In Brazil, it is found in the region of the Cerrado biome, mainly in the states of the Amazonas, Minas Gerais and Goiás (Martins, 2012) with dense populations in humid areas, gallery forests and footpaths. It is considered like a key species in the footh paths environment (Resende *et al.*, 2012) defined by CONAMA Resolution nº 303/2002 (Brazil, 2002), as a swampy or flooded space, containing springs or headwaters of water courses, where occurs

hydromorphic soils with predominance of rows of marsh buritis and other forms of typical vegetation.

This palm is widely distributed in South America (Virapongse *et al.*, 2017). buriti fruits are harvested throughout the Peruvian Amazon for subsistence and commercial purposes. Recent estimates suggest that residents of Iquitos, the largest city in the region, consume approximately 148.8 metric tons per month, the vast majority of which are harvested by felling and killing adult trees (Gilmore, Endress & Horn, 2013).

In the city of Barreiras and throughout the region that covers western Bahia, buriti is of great economic importance both for the riverside populations and for people who live in the urban area. They take advantage of the harvest season of the species to make a profit both on the sale by-products of the fruit (production of ice cream,

popsicles, sweets, jams, cocadas, oil extraction, production of medicines, etc.) as well as in the extraction of the palm tree for handicrafts (manufacture of baskets, tables, chairs, among others). For this reason, the university has a socio-environmental commitment to guarantee the conservation of this species.

The native seed nursery at the State University of Bahia - UNEB located in Barreiras, since its creation has as its main function the production of native seedlings to restore areas impacted by agricultural exploration in the region. For this purpose, seedlings of different species are produced annually, giving preference to the production and perpetuation of species that are in constant threat of extinction and that have regional importance and species that have dormant seeds since this characteristic slows down the perpetuation. This is a way of guaranteeing the conservation and preservation of Cerrado species.

Most Arecaceae species have difficulties in germinating, even under suitable conditions, making seedling production difficult (Seleguini *et al.*, 2012). Martins Filho *et al.* (2007) evaluated different substrates in the development of palm seedlings and concluded that the species show different behavior in relation to the evaluated substrates. The development of seedlings inside the nursery has to occur in an accelerated way due to the limited space and resources. Therefore, knowing the ideal substrate for each species, creates a protocol of agility of this work for nurseries because of the possibility of using substrates that guarantee the development of healthy seedlings with a high survival rate in the field.

Andrade *et al.* (2013) found that the use of sieved wood bark along with sugarcane bagasse with bovine manure are efficient to develop seedlings of native trees from the cerrado and favored the initial growth of aroeira seedlings (*Myracrodruon urundeuva* Allemão) in western Bahia, becoming a viable alternative for seedling production. Bovine manure, both with sand and in a mixture with commercial substrate Bioplant®, were also the best substrates for growth in height and diameter of the collection and production of total dry mass in açai seedlings (*Euterpe oleracea* Mart.), according to Sousa *et al.* (2018).

The aim of this work was to identify suitable substrates for the development of buriti seedlings.

II. MATERIAL AND METHODS

Experimental area

The experiment took place in the nursery for the production of native seedlings in the Cerrado Biome,

located at the State University of Bahia, Department of Human Sciences, *Campus IX*, Barreiras, Bahia, Brazil.

Fruit harvesting and seed processing

The fruits were collected on the soil surface under the matrices in an area of footpath located in the community of Perdizes, in the municipality of São Desidério - Bahia at coordinates 12 ° 26 '43.7 "S and 45 ° 22' 05.3" W. The fruits were processed and removed from the pulp to obtain the seeds. They were washed with water and neutral detergent and then placed in a 1% sodium hypochlorite solution for 5 minutes, then placed to dry the shade for 2 hours. Finally, the seeds were subjected to mechanical scarification in sandpaper on the opposite side to the embryonic axis.

Sowing took place in white trays with a capacity of 20 liters of substrate and was suspended in masonry and wood structure, thus avoiding direct contact with the nursery soil. Forty-five seeds were sown by trays with a spacing of 4.5 cm between them and an approximate depth of 3.0 cm.

Substrates

The substrate used was sand from a river. Wood shavings were purchased from lumber companies in the city of Barreiras – BA. The material used was from random trees of unknown origin with no type of wood shavings being selected.

The sugarcane bagasse was collected in local stores, distributed in the city of Barreiras, taken to the laboratory, dried in an oven at 70 ° C for 72 hours, then, crushed in the machine into pieces of approximately 9.5 mm in diameter.

The soil used was horizon B of the dystrophic red-yellow Latosol, from the property of *Campus IX* of UNEB. The soil was sieved in a grain sieve with a 5.5 mm mesh. The cattle manure used was previously tanned and then sieved through a 5.5 mm mesh grain sieve.

The footpath soil came from the same area where the fruits were collected. The soil was collected in the superficial layer, taking care to remove the first 5 cm and collecting it up to 20 cm deep. Still in place, the soil was sieved in a grain sieve with a 5.5 mm mesh. The substrates (treatments) were sterilized in an autoclave for 2 hours at 120°C and were composed according to Table 1.

Table 1: Treatments composition. Barreiras–BA, UNEB 2020.

TREATMENTS	Composition				
	Sand	Wood shav.	Soil	Sugarcane bag.	Manure
T1	Sand	100%			
T2	Sand +Wood shavings	20%	80%		
T3	Sand + Soil	80%		20%	
T4	Footpathsoil	100%			
T5	Sand+ Manure	75%			25%
T6	Soil		100%		
T7	Soil + Wood shavings		80%	20%	
T8	Soil + Sand	80%		20%	
T9	Soil + Sugarcane bagasse		20%	80%	
T10	Soil + Manure		75%		25%

The experiment was irrigated in the morning and in the afternoon for 10 minutes in each period, by a micro-sprinkler system installed in the nursery with a 50% brightness shade. If it rains, the trays will be covered to avoid external interference with irrigation.

Biometric parameters

The emergency speed index (IVE) was calculated using the methodology proposed by Schwerz *et al.* (2010), using the formula $IVE = \sum Ni / Di$, where Ni is the number of seeds emerged in Di days after planting.

The stem length was measured every 7 days after emergence at 7, 14 and 21 days with a millimeter ruler (cm), as well as the stem diameter was measured using a digital caliper (mm). At 21 days, the experiment ended,

and the root size was measured with a millimeter rule (cm) and the fresh and dry masses of the aerial part and the root were obtained.

The Dickson Quality Index $IQD = MST / (H / DC) + MSPA / MSR$ (Dickson, Leaf & Hosner, 1960) was used to evaluate the seedling quality standard. Where MST = Total dry mass; H = length of the aerial part; DC = stem diameter; $MSPA$ = Dry mass of the aerial part and MSR = Dry mass of the root. The relationship between shoot length and stem diameter and the dry mass of the aerial part and dry mass of the root were also analyzed.

Chemical analysis of substrates

The substrates were sent for chemical analysis and results were obtained according to Table 2.

Table 2: Chemical analysis of the substrates: Calcium (Ca), Magnesium (Mg), Potassium (K), Phosphorus (P), Organic matter (O.M.), Cation exchange capacity (CEC) and Saturation by Base (S Base).

Substratos (%)	Ca mg ³	Mg mg ³	K mg ³	P mg ³	Al mg ³	O.M. g kg ⁻¹	CEC Cmol	S Base Cmol
Sand (100)	1,00	0,50	12,44	4,80	0,00	0,70	3,03	50,52
Sand(20)+Wood shavings (80)	2,80	0,80	84,00	14,60	0,00	6,20	8,72	43,78
Sand (80) + Soil (20)	2,40	0,60	35,80	2,30	0,00	0,80	4,59	67,33
Footpathsoil (100)	0,60	0,30	17,10	4,60	0,50	5,30	7,74	12,19
Sand (75) + Manure(25)	3,20	0,80	988,00	84,60	0,00	5,40	7,33	89,09
Soil (100)	2,00	0,90	118,00	6,90	0,00	2,64	5,60	57,16
Soil (80) +Wood shavings (20)	1,80	1,20	138,60	5,60	0,00	8,80	7,96	42,18
Soil (80) + Sand (20)	2,70	0,70	74,00	3,90	0,00	2,80	5,89	49,06
Soil (20) + Sugarcane bag. (80)	0,50	0,40	600,2	28,80	0,70	6,20	10,24	23,82
Soil (75) + Manure (25)	3,00	0,20	770,80	43,90	0,00	3,60	7,68	80,46

Statistical analysis

The experimental design was randomized blocks with 10 treatments and four repetitions. The results obtained were subjected to analysis of variance and the treatment averages compared by the Duncan test at 5% probability, using the Software SAS (Statistical Analysis System), version 9.1 (SAS Institute, 2003).

III. RESULTS AND DISCUSSION

The results of the analysis of variance were significant at 5% significance for the Emergency Speed Index - IVE, indicating that the treatments are different. The Duncan average test was performed for this purpose and it was possible to observe that the substrate composed of sand was statistically superior to the other substrates, and should therefore be indicated to obtain a greater emergence in the culture under study (Table 3). Although the sand has

a low amount of nutrients and retains little water, the embryo needs little of the substrate in the first days, as it contains a significant amount of endosperm. Carvalho (2012) evaluated the buriti on different substrates and according to the authors the species has slow germination and is characterized as being of an adjacent ligulated type, which shows the dependence of the endosperm for its nutrition.

In this experiment, buriti seeds began to emerge from 30 days to 121 days, however, dormancy was overcome, which facilitated germination. According to Sousa *et al.* (2005) buriti seeds have slow germination with marked unevenness, starting seedling emergence 40 days after sowing and stabilizing at 260 days. The germination percentage was higher in the substrate containing sand (75%) + manure (25%) and did not differ from the other substrates.

Table3: Emergency speed index – IVE, Percentage of Germinated Seeds - PG%, buriti seedling Stem Length depending on the substrate used. UNEB, Barreiras, BA, 2020.

Substrates (%)	IVE	PG%	Steem lenght (cm)		
			7 days	14 days	21 days
Sand (100)	62,9 a	0,69 ab	20,11 bcd	22,95 bc	25,61 bcd
Sand (20) +Wood shavings (80)	24,5 b	0,67 ab	17,98 cd	20,52 cd	23,68 de
Sand(80) + Soil (20)	35,9 b	0,70 ab	24,26 b	27,21 b	30,08 ab
Foothpathsoil (100)	26,2 b	0,73 ab	29,92 a	31,99 a	34,11 a
Sand (75) + Manure (25)	37,1 b	0,80 a	21,57 bc	24,52 bc	27,82 bcd
Soil (100)	37,2 b	0,73 ab	21,25 bc	24,58 bc	17,38 bcd
Soil (80) + Wood shavings (20)	28,3 b	0,71 ab	19,54 bcd	21,81 cd	24,31 cde
Soil (80) + Sand (20)	21,3 b	0,58 ab	24,15 b	26,85 b	28,84 bc
Soil (20) +Sugarcane bagasse (80)	23,0 b	0,62 ab	16,18 d	18,13 d	20,41 e
Soil (75) + Manure (25)	29,2 b	0,55 b	21,77 bc	23,82 bc	27,39 bcd

Means followed by the same letters do not differ by Duncan's test at 5% significance.

The Table 3 shows the stem length data for the buriti seedlings, at 7, 14 and 21 days after germination, depending on the substrate. It is observed in this table that the substrate with only footpath soil presented the longest length in the three dates when it was measured, which was significantly longer than the others, except for the 21 days that it was not superior to the substrate with 80% sand plus 20% of soil.

Sousa *et al.* (2011) studied the footpath soils of the cerrado biome and according to the authors, the footpaths are humid ecosystems, generally associated with hydromorphic soils and the outcrop of the water table, frequently occurring near the springs and water courses in the Cerrado region. Through the chemical analysis of the

substrates it was possible to verify that the substrate containing only footpath soil presented low levels of potassium (K) phosphorus (P), magnesium (Mg), as well as the other nutrients that are described in the literature as essential for the good plant development. However, this did not influence the development of buriti seedlings, since the diameter was also significantly larger in seedlings containing only footpath soil at 7, 14 and 21 days.

According to Passos *et al.* (2015), the Cerrado area close to the footpath had very low natural fertility, especially low concentrations of phosphorus and organic matter (M.O.). In relation to the latter, it corroborates with the results presented in the studies by Nunes *et al.* (2019) in which native Cerrado soils showed about 2.43% of

O.M. While Silva Junior (2019), studying this parameter in soil samples from agricultural areas and native areas of 10 micro-regions in western Bahia, found even lower values for soils from the native Cerrado that reached 1.52% of O.M in the region's average, which is considered low, according to the classification suggested by Ribeiro, Guimarães e Alvarez (1999). Even so, because it is a native species, buriti is adapted to these conditions, managing to establish itself in these areas.

It was also possible to observe aluminum levels only in the soil and footpath treatments and in the Soil (20) + sugarcane bagasse (80) treatments. Aluminum is a toxic

element for plants. In the work by Passos *et al.* (2015), when assessing footpath soils, high levels of aluminum were also identified, which is a characteristic of the cerrado soil.

The Table 4 shows that the stem diameter of buriti seedlings in footpath soils (100%) tends to be larger, however, there is no statistical difference for substrates with sand (80%) + soil (20%), soil (100%), soil (80%) + sand (20%) and soil (75%) + manure (25%). In general, the stem diameter of buriti seedlings was influenced by the substrate.

Table 4: Diameter of buriti seedling stem according to the substrate used. UNEB, Barreiras, BA, 2020.

Substrates (%)	Stem diameter (mm)		
	7 days	14 days	21 days
Sand (100)	8,43 b	8,62c	8,62c
Sand (20)+ (80)	8,66b	8,66c	8,66c
Sand (80) + Soil (20)	9,43ab	9,68 abc	9,68abc
Footpathsoil (100)	10,06 ^a	10,5 a	10,5a
Sand (75) + Manure (25)	8,81b	9,12bc	9,18bc
Soil (100)	9,22ab	9,68 abc	9,81ab
Soil (80) +Wood shavings (20)	8,62b	8,93bc	8,93bc
Soil (80) + Sand (20)	9,37ab	9,75 ab	9,81ab
Solo (20) + Sugarcane bagasse (80)	8,31b	8,75 bc	8,81bc
Soil (75) + Manure (25)	9,18ab	9,56abc	9,62abc

Means followed by the same letters do not differ by Duncan's test at 5% significance.

Regarding the fresh and dry mass, the footpath soil showed the best results, however the fresh mass did not show any significant difference for the substrate in which 80% sand was used plus 20% soil, while the dry mass was significantly different from all the others (Table 5). Regarding the root length, the soil, footpath soil (80) + wood shavings (20) and sand (80) + soil (20) treatment did not differ statistically, which are the most recommended to obtain a good root growth of buriti.

The fresh and dry root mass was superior in the treatment containing sand (80)+ soil (20), and it was also possible to observe satisfactory results in the soil (80) and footpath soil (20) + wood shavings (20) treatments (Table 5). These substrates, when compared to nutritional

contents, have totally different characteristics, however both guaranteed satisfactory root growth, as well as for dry matter. According to Haridasan (2008), the concepts of plant nutrition and toxicity that are well established in agriculture, should not be extended to native plants in natural ecosystems, indiscriminately. The great number of species of native plants that occur in the biome are resistant or tolerant to edaphic conditions considered unfavorable to cultivated plants. Perhaps the differences in nutrient concentration observed had a radical influence on cultivated plants, which does not occur in this experiment, where the presence of aluminum and the low concentrations of essential nutrients did not negatively influence the development of buriti seedlings.

Table 5: Fresh and dry mass of the aerial part, Length, fresh and dry weight of buriti seedling roots depending on the substrate. UNEB, Barreiras, BA, 2020.

Substrates (%)	FAPM (g)	ADM (g)	RL (cm)	FRW (g)	DRW (g)
Sand (100)	5,33 bcd	1,26 bcd	20,30 bc	2,47 bc	0,63 b

Sand (20)+Wood shav. (80)	5,76 bcd	1,30 bc	18,91 c	2,92 abc	0,75 ab
Sand (80) + soil (20)	6,91 ab	1,57 b	24,59 ab	3,73 a	0,95 a
Foothpathsoil (100)	8,24 a	1,91 a	26,01 a	3,42 ab	0,76 ab
Sand (75) + Manure (25)	5,74 bcd	1,34 bc	19,62 c	2,57 bc	0,66 b
Soil (100)	6,25 bc	1,36 bc	17,48 c	2,36 c	0,62 b
Soil (80)+Wood shav. (20)	4,93 cd	1,14 cd	25,38 a	2,70 bc	0,72 b
Soil(80)+Sand (20)	6,34 bc	1,40 bc	20,40 bc	3,07 abc	0,73 b
Soil (20)+Sugarcane bag. (80)	4,33 d	0,94 d	21,72 abc	2,33 c	0,60 b
Soil (75)+Manure (25)	5,98 bc	1,32 bc	21,50 abc	3,21abc	0,73 b

Means followed by the same letters do not differ by Duncan's test at 5% significance. FAPM: Fresh aerial part mass; ADM: Aerial dry mass; RL: Root length; FRW: Fresh root weight; DRW: Dry root weight.

When assessing the Dickson Quality Index (DQI), significant differences were observed between the substrates, indicating that the substrate containing sand (80%) + soil (20%) showed better quality seedlings (Table 6). The higher the value of this index, the better the seedling quality standard (Gomes & Paiva, 2012). The DQI is used in studies that deal with morphological

parameters related to seedling quality (Rosa *et al.*, 2009; Caione, Lange & Schoninger, 2012; Garcia & Souza, 2015; Sousa *et al.*, 2018), being important for considering the vigor and balance of the distribution of biomass in the seedling which involves the results of several important parameters used to assess quality.

Table 6: DQI - Dickson Quality Index and relationship between Dry Mass of the Aerial Part and Dry Mass of the root, Stem Length (cm)/Diameter (mm) ratio of buriti seedlings. UNEB, Barreiras, BA, 2020.

Substrates (%)	DQI	DMAP/ DMR	Stem length (cm)/ Diameter ratio(mm) ratio		
			7 days	14 days	21 days
Sand (100)	0,37 b	2,05bc	2,37 bc	2,65 ab	2,96 ab
Sand (20)+Wood shavings (80)	0,45 ab	1,76 cd	2,10 bc	2,39 bc	2,76 abc
Sand (80) + Soil (20)	0,52 a	1,70cd	2,56 ab	2,80 ab	3,10 ab
Foothpathsoil (100)	0,46 ab	2,50a	2,98 a	3,06 a	3,24 a
Sand (75) + Manure (25)	0,39 b	2,04bc	2,44 bc	2,68 ab	3,03 ab
Soil (100)	0,39 b	2,26ab	2,31 bc	2,54 bc	2,80 ab
Soil (80) + Wood shavings (20)	0,43 ab	1,57d	2,28 bc	2,44 bc	2,73 bc
Soil (80) + Sand (20)	0,43 ab	1,93bcd	2,59 ab	2,76 ab	2,95 ab
Soil (20) + Sugarcane bagasse (80)	0,39 b	1,61	1,95 c	2,07 c	2,32 c
Solo (75) + Manure (25)	0,44 ab	1,81cd	2,36 bc	2,50 bc	2,84 ab

Means followed by the same letters do not differ by Duncan's test at 5% significance.

The DMAP/ DMR ratio was also higher in the soil substrate (100%) (Table 6). This result indicates a balance between the aerial part and the root. This balance avoids future tipping, as well as seedlings with a well-developed root system are more likely to survive in the field, especially if you are in an environment with water limitations (Lima *et al.*, 2008).

There was a greater stem length/stem diameter relationship for the soil substrate (100%) at 7, 14 and 21 days (Table 6). This corroborates with the studies by Souza

et al (2018) in which the substrates presented the best growths in height and diameter of the collection and increased the production of total dry mass in seedlings of *Euterpe oleracea* Mart. over a period of 60, 90, and 120 days using sand and cattle manure. According to Araújo *et al.* (2017), this non-destructive evaluation method represents the plant's growth balance. The stem diameter is one of the best indicators of the seedling quality standard and is correlated with the initial survival at the time of

planting, and there must be a diameter compatible with the height (Frigotto *et al.*, 2015).

IV. CONCLUSION

The conclusion was that the footpath soil provides better development of the buriti seedlings (100%), which is the most recommended for a quick nursery production. However, due to the difficulty in obtaining this material, sand (80%) + soil (20%) can be used to replace the footpath soil with similar results.

The deepening of studies related to the production of seedlings of species of socio-economic cultural interest are fundamental to corroborate the conservation actions of the native flora of the different Brazilian biomes.

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Educational Processes in Administration in the Informatization Era

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Keywords— Administration education.
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Abstract— The present work makes a theoretical-reflective reading about the education in the administration courses in interface with the technologies. As assumptions of the analysis, we provide an overview of how the use of mobile digital technologies can enable an education focused on qualified training, which propels the professional in training to the world of work.

I. INTRODUCTION

Teaching and instruction have always been part of human relationships in a non-formal way. Knowledge and information, throughout the development of humanity, are elaborated and shared. In formal education, the educator becomes a facilitator in the construction of knowledge by the student, who must become autonomous in this construction. It is in this sense that we dialogue, in this work, with the perspective of Freire (1996, p. 47), who affirms that “teaching is not transmitting knowledge, but creating the possibilities for its own production or its construction”.

In this context, it is clear that the world is changing rapidly, new discoveries are happening quickly and the distance between the present and the future becomes smaller and smaller.

Making a brief link between the informational age and my perception of the experience in the classroom since 2003, it is notable the increasing lack of focus and / or misuse of Mobile Digital Technologies of Information and

Communication (TDMIC) by the body teacher and mainly by the student body, where they are fascinated with technological innovations, which can probably result in an increase of anxiety when notifications and messages arrive through social networks.

Modern society has been facing the changes imposed by technological evolution on a daily basis, accompanying and driving this social and cultural transformation, affecting the way people learn, think and relate.

In this sense, the daily challenge of education from pre-school to higher education is precisely to reconcile the teaching / learning process by extracting the maximum of the potential that technology provides, in the perspective of improving the training of man and the development of society.

II. EDUCATIONAL PROCESSES AND COMPUTERIZATION

The computer, automation and TDMIC revolution has defended new means to the educational context. In the information age (from 1990 onwards), also known as the knowledge society arising from the information revolution, the perception of the need to increase the quality of teaching / knowledge that generates competitive intelligence is clear, as well as the knowledge of students by schools of higher education. higher, otherwise, it can cause an incipient problem.

Martin (1996), makes a brief summary which portrays the era of knowledge well, where definitely, this great transition will be more devastating than the Industrial Revolution. The forces that are shaping it include global information superhighways, investments in countries with cheap labor, international partnerships, downsizing, the concept and teams of value flows, quality revolution, powerful microelectronics, cyberspace, virtual operations, agile production and the reinvention of management.

In the same way, as the existence of a certain deficiency / lack of the use of TDMIC as a technological mediating tool capable of strengthening the learning of students and even teachers, who nowadays do not learn more as teachers were traditionally taught, when many had no digital technological apparatus.

It should be emphasized that traditional teaching method is understood in which the teacher is the active subject of the teaching-learning process, having greater control of the classes, giving preference to the expository classes and carrying out exercises, passing on his knowledge to students almost always. theoretical form (FREIRE, 1996). Classes are centered on the teacher, who defines what content will be passed on to students, as well as the organization of how the teaching-learning process will be carried out (SANTOS, 2011).

This situation may lead us to the lack of public policies for continuing education for teachers, aiming to supply such shortcomings, enabling the handling of these technologies, or if the teaching professional has not yet assimilated the importance of this tool to contribute to the student's learning inside and outside the school. classroom, or both. It is possible to affirm that technology is present in all scenarios, places, in any and all parts, being one of the most discussed subjects nowadays. According to Costa (2012, p. 2), this multifaceted reality instigates and causes problems and challenges for the education professional, allowing him to reflect on himself, in a permanent process of becoming.

This relationship converges, in contemporary times, to the virtual. Even with the advent of the internet and the

popularization of technology, the role of the teacher remains essentially unchanged, as previously endorsed: creating possibilities for the autonomous construction of knowledge perpetuating for the next generations. Knowing that information is the triggering element of transformations in people's lives, there is this new challenge for students and especially for teachers, in incorporating this new technological resource in schools, maximizing learning and the excellent relationship between them, that is, the appropriation of the communication tools made available thanks to the technological resources used in higher education.

The use of mobile digital technologies inefficiently, driven by common sense or influenced by other people, without knowing the real benefits they can bring, just out of fashion or because someone imposes, in many cases, does not contribute to a class different from the traditional one (class with verbal exposition, focus on exercises and memorization of contents, with home and written evaluations, where the teacher, often authoritarian, brings the content ready and the student just listens to it) which does not make students developers of recognizing skills and competences to be present in the digital age.

New and different literacies in the contemporary world are being imposed by the means of communication and circulation of information, where the processes give rise to a great variety of other literacies. According to Street (1984, p. 20), the model of social practices assumes that the meaning of literacy depends on the social institutions in which it is inserted, and that the specific practices of reading and writing that are taught in any context depend on aspects of social structure such as stratification, and therefore, are not universal.

Literacy cannot be taken for granted, as it is always evolving. In this sense, Street and Lefstein (2007, p. 42) affirm that

[...] the way teachers and students interact is a social practice that affects the nature of the literacy that is being learned and the ideas about literacy that the participants have, especially the new apprentices and their positions in power relations.

It is emphasized that this new digital learning scenario, where everyone can be a producer, recipient and propagator of content, enables the improvement of skills, so we defend here the need to rethink the qualities for all involved in teaching and can generate mutual success with access to websites, links, footnotes, readings of the non-verbal, challenges of making the school meaningful in terms of access to knowledge and information.

III. THE TEACHING PRACTICE IN ADMINISTRATION

Approaching a little about Administration as a science, it can be defined in many ways. There is no single definition. For some famous writers, such as Peter Drucker, Philip Kotler, Stephen Paul Robbins, Idalberto Chiavenato, among others, managing is an art. Chiavenato (2007, p. 3) states that "Management is the vehicle by which organizations are aligned and led to achieve excellence in their actions and operations in order to achieve success in achieving results".

It requires administrative practices for an organization to grow and achieve its goals, managing financial and human resources, taking into account the basic principles of administration, which are directing, planning, coordinating, organizing and controlling, effectively establishing negotiations, goals, identifying and solving problems diverse, leading people, making strategic and correct decisions, among others.

It must be remembered that for the company to achieve its objectives, it is necessary to prepare its planning in advance, be it sectorial / departmental or general, the latter also known as Organizational Planning, Strategic Planning or Business Planning. For the execution of what was planned, it is necessary a lot of organization, discipline and people who do it with support from the high organizational top.

According to Chiavenato (2000), it is necessary to determine in advance which organizational objectives must be achieved, and to achieve them, goals must be set within a planning preliminarily prepared and executed by all employees, as the basis of administrative functions.

Once the planning is defined and the organization is established, it remains to make things move and happen. This is the role of management (leadership): to activate and dynamize the company. Direction (leadership) is related to action, getting started, and has a lot to do with people. It is directly related to the performance of the company's human resources (CHIAVENATO, 2000, p. 7).

Management education requires renewal, a link between theory and practice, the development of a critical and analytical view of management practices, strategies, skills and competences that also involve the intensive use of digital technologies. In this sense, Petrucci and Batiston admit that:

[...] the word 'strategy' has a close connection with teaching. Teaching requires

art on the part of the teacher, who needs to involve the student and make him delight with knowledge. The teacher needs to promote curiosity, security and creativity so that the main educational objective, student learning, is achieved (PETRUCCI; BATISTON, 2006, p. 263).

Regarding the use of digital technologies in the teaching-learning process, Anastasiou; Alves (2004) say that it is the opportunity for a group of people to be able to debate, at a distance, a topic on which they are experts or have carried out a previous study, or want to deepen it electronically.

Still on this subject, Petrucci; Batiston (2006) report that the tools used in distance learning range from the simplest, such as teaching by correspondence without support or tutoring, through communication only between educator and student, to the most sophisticated methods, which include interactive schemes of non-face-to-face communication via satellite, or computer networks.

In this sense, the activity of professors in Administration is characterized by daily challenges, seeking to maintain interpersonal relationships with students, who expect the teaching staff to have an enhanced, outstanding performance.

Without having to list the various factors, it is known that the internet has been growing markedly in Brazil, where, many times, young people do not have a real knowledge of the importance that this technological tool can generate in academic and, consequently, professional life, noting there is a focus on the use of social networks, weakening concentration and dedication to studies. Also, it can cause addictions (excessive use of the device in social networks, games, animation applications, humorous, pornographic sites, etc.) that can negatively interfere in the production of knowledge and, most likely, the young person's rise in the market of work.

IV. FINAL CONSIDERATIONS

The market changes are noticeable and continuous with incessant technological innovations and in particular to cell phones with internet access that become increasingly sophisticated, immense variety of applications, whose use is in profusion, due to several factors, among them the very competition, and for this reason, companies that manufacture / generate technology must always be attentive, react, have flexibility and adapt, tracing strategies essential to their survival.

In education, the scenario is not very different when it comes to the technological nature as a mediating tool for

teaching / learning, which has been transforming the school routine.

It is also emphasized the importance of immersion of the teacher as a professional in the acquisition of basic knowledge, at the same time broad and multidisciplinary, starting a path in search of educational quality which will provide a better production and construction of knowledge to the student, generating knowledge so demanded in this fierce and increasingly competitive market, that it allows social transformations, enabling a society with more equity for all.

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Sensitivity analysis in the rearing of beef cattle in the State of Pará

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Keywords— Cattle culture, Cost management, Farmer.

Abstract— Brazil, a major meat producer and exporter, has the largest commercial herd in the world with about 215 million heads, as Pará is in the 4th position in number of cattle in the country, with 22 million heads. In the country 80% of the farms are beef cattle, having reared in all Brazilian municipalities, mostly calf production, many producers do not have the records of information on the cost of production and the viability of the business, sensitivity analysis and important instrument, and of total importance because it helps to know the results, profitability for decision making. Thus, this objective was to make a sensitivity analysis, for this we made a case study, where zootechnical indexes were raised, the support of the property and made a projection of the herd, during the period of 10 years, to find the revenue and verified the expenses both fixed as the variable, and also investments in the infrastructure to find the expenses of the property in the period, the economic indexes were found and sensitivity analysis was made, in a rural property in Santa Maria das Barreiras, in the State of Pará. Concluding that project is robust and feasible, with attention to expected profitability.

I. INTRODUCTION

Brazil has consolidated itself as a major producer and exporter of meat in the international market, the country has the largest commercial herd in the world with approximately 215 million heads, Pará has the 4th largest herd in the country, with a carca of 22 million heads and the largest of buffaloes with 556,000 animas, the municipality with the largest herd in the country and São Felix do Xingu with 2.2 million heads [1 and 2], being

very expressive the breeding of animals for both small, medium to large producers. Beef cattle represent 80% of the country's herd being very important for the country [3].

The creation of beef cattle and an activity that is present in almost all Brazilian municipalities, being commonly used in cattle farming the production of calves, or fattening, or even producers that can produce the complete cycle of production, creates, recreates and fattening, always seeking the highest profitability, with

this the country has been gaining leadership in the world trade in meat [4], in 2019 livestock farming contributed 32% of the PIB national level, with about R\$ 494,8 billion sum of goods and services generated [5].

Knowing what the production costs and total importance for an efficient management of the property, and fundamental for the planning of activities, facilitating in decision making, as much as and when to invest, as well as control enabling greater profitability, it is necessary to plan the property as a rural company [6].

It is necessary that the producer has information that allows a greater knowledge of resources, bringing ease to the same in decision-making on the continuity or discontinuity of production, whether it will continue producing calf (calf) to sell, or hold a little more and sell garrote (recreates), or even the sale of fat ox (fat tenuin), and also the complete cycle (creates, recreates, fattening), this entrepreneur must seek knowledge to facilitate in his administration, with this seeks his profitability and should note that in most properties revenues are obtained in a few months, and expenses are dissolved throughout the year [7].

Producers are, and should be seen as managers of their rural companies, and for their survival in the current market should be updating and adapting, with the use of management practices to guide them and better production and satisfactory results for their production chain, always observing the property as a company, one different from the other with its peculiarities and reality of it, regardless of the size of the area, and notorious compression on management and the entire production process, knowing the quantity and how it will produce and the cost of the product it will offer, and when it will be available for sale, this will be essential to manage the resources of the rural company, obtaining the desired results [8].

One of the problems observed in some producers and lack of registration of information about their cost of production, the rural entrepreneur should be attending to the new technologies that passes facilitates their observation of spending as control of their property, thus leaving more competitive before the current market. It can adopt the best strategies for your activity, with lots of market observation and trends [9].

The rancher usually does not have the complete knowledge about costs and production factors, which would facilitate his decision making risk analyses are important, in economic assessment, allowing a numerical visualization involved in a rural company, within the risk analysis [10].

The economic feasibility analysis of an investment may be possible through the use of specific methods or

complementary analyses, such as risk analyses, which work with probabilities and scenario simulations, which allows identifying the risks of the enterprise, taking into account a large set of variables [11, 12 and 13].

Thus, the economic feasibility analysis of an Investment Project can occur through the Multi-index Methodology, using various return and risk indicators, such as Net Present Value (VPL), Payback, Internal Rate of Return (TIR), so that these provide that the analysis performed is more reliable, when considering the uncertainties of the different scenarios and the probabilities of risks that should be weighed [14, 15, 16 and 17].

The sensitivity analysis and used to estimate the effect that a change in price, production level, cost of capital opportunity, or the combination of these factors causes on the final economic result. Sensitivity analysis and a convenient and fast method of determining the approximate impact, on the change in one or more of the productive factors, had caused the final economic result [18].

In view of the above, this study aims to know the sensitivity analysis in a breeding of beef cattle in the state of Pará.

II. MATERIAL AND METHODS

The experiment was conducted at the Vitoria site located in (08°18'32"S 50°36'58"W) in the municipality of Santa Maria of Barreiras - PA, in the transition from the cerrado biome to the Amazon. Access to property takes place via highway PA 150 to km 20 (sense Redenção x Casa of Taboa), enters the right following by 60 km of unpaved highway in the vicinal 31, after the farm Chupé more 9 km.

The predominant climate (Figure 1) in the region is classified according to Köppen as Aw, tropical with dry season in winter [19].

The property contains 113.60 ha, of legal field that are occupied with artificial pastures in most with urucloa brizantha and panicum maximum.

The topography of the property and predominantly plant, has some areas of lowland, much of the area of the property and mechanized approximately 90% with tire tractors.

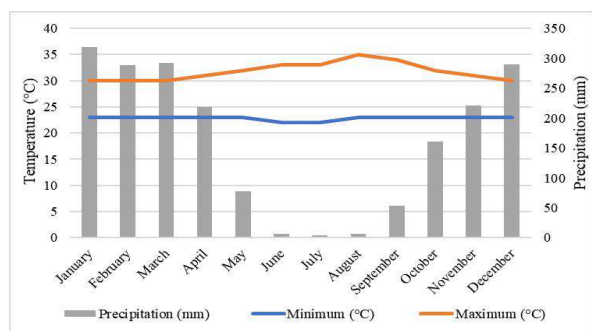


Fig. 1: Precipitation climatological averages, minimum temperature and maximum of the municipality of Santa Maria of Barreiras, Estado of the Pará in the year of 2019.

Fonte: Climatempo [20].

Table 1: Results of chemical and physical analysis of soil in the layer 0-20 cm corresponding to the area in Santa Maria of Barreiras – PA.

Ca	Mg	Al	H+Al	Argila	Silte	Areia
	cmol _c dm ⁻³			%	%	%
1.3	0.8	0.3	2.5	21	6	73
P	S	Zn	Mn	Fe	Cu	B
			mg dm ⁻³			
6.7	2	1.5	30.6	245	1	0.23

Font: Solocria [21].

The property includes a small river called rust and two medium-sized dams that supply the demand for water from the property, while the demand for the home is provided by a semi-artesian well used this water for human consumption and small domestic animas.

It includes 10 divisions of pasture and corridors to facilitate management, as well as a remanga to close the herd, each pasture has trough for placement of mineralized salt and access to water, in the dams or watercourse already described.

On the day 10/02/2021 the herd was performed and the approximate age of each bovine of the property was performed to collect the data to be inserted in the GERENPEC. Three equidae were used for the management of cattle (touching them), and it was requested with Agricultural Defense Agency of the Pará (ADEPARA), issue the property's health record.

Zootechnical indices, such as birth, mortality, such as weight approaching the animal category moving to UA, Diagnosis was used for property planning [22], as the property does not yet have a corral with precision scale,

Soil analysis was performed on the property (Table 1), so that calage and fertilization can be done correctly, later.

Table 1 - Results of chemical and physical analysis of soil in the layer 0-20 cm corresponding to the area in Santa Maria of Barreiras – PA.

and due to the evaluation will be carried out for more than 1 year, and the weight of the animas try to vary over the years. For data analysis, the system was used (sheet) of Embrapa Gado from Corte GERENPEC 1.0 [23].

For the study of economic viability and sensitivity analysis, it was used by the Kassai [18].

III. RESULTS AND DISCUSSION

In addition to the prices of the animals, field research was carried out with the Magnos Leilões, company based in Redenção - PA, with various producers and buyers of cattle (Middlemen) in the region of Serra Azul (Santa Maria of Barreiras), where the property is located, while the values of @ cattle, the Company's Quotes were used Scot Consultoria [24], as shown in the Table 2.

Table 1: Marketing of breeding, fattening and slaughter cattle.

Specification	Epoch	Unit	Quantity	Value unit (R\$)	Value full (R\$)
Calf fat	24 the 30 Months	@	18	274	4932
Calf thin	24 the 30 Months	Cb	1	3900	3900
Heifer	24 the 36 Months	Cb	1	3300	3300
Garrote	12 the 24 Months	Cb	1	3000	3000
Garrota	12 the 24 Months	Cb	1	2600	2600
Calf	7 the 12 Months	Cb	1	2500	2500
Heifer	7 the 12 Months	Cb	1	2000	2000
Cow discarded	Fat	@	12	270	3240
Discarded bull	24 the 30 Months	@	22	274	6028

Source: Scotconsultoria [24].

Table 3 refers to the price by category of farm animals, for the analyzed property was chosen the nellore or anelorada, because and a breed that adapted very well, in several regions of the country, with resistance to high temperatures, good ability to use fibrous foods, fodder,

less attacked by ectoparasites and rusticities compared to European breeds, in general have undergone genetic improvement, at least breeding (bulls), being an excellent animal for grazing [25].

Table2 Cattle of offspring for cutting - herd formation.

Specification	Race	Unit	Quantity	Value unit (R\$)	Value full (R\$)
Reproducer P.O	Nellore	cb	2	15000	30000
Reproducer L.A	Nellore	cb	1	10000	10000
Mother (3 years)	Anelorada	cb	1	3500	3500
Heifer (2 the 3 years)	Anelorada	cb	1	3200	3200
Heifer (1 the 2 years)	Anelorada	cb	1	2600	2600
Heifer (7 the 12 Months)	Anelorada	cb	1	2000	2000

Source: Field research.

The next Table 4 shows the prices of animals that are used in the management of the property, which has three equidae all horses, but more equidae were conducted that

are commonly used in properties in the region such as the muares (Donkeys and Mules).

Table 3 Working animals.

Specification	Age	Unit	Quantity	Value unit R\$	Value full (R\$)
Lover boy	3 the 5 years	cb	1	1,000	1,000
Horse	3 the 5 years	cb	1	700	700
Mare	3 the 5 years	cb	1	300	300
Donkey (tame)	3 the 5 years	cb	1	1,000	1,000

Source: Field research.

The costs of deploying one kilometer of fence are in Table 5. On the other hand, the amount of expenses in the

reform and maintenance of pasture is in Table 5, referring to 1 hectare, being carried out in a mechanized way.

Table 4: Annual expenses and expenses in the creation system.

Specification	Unit	Quantity	Value unit (R\$)	Value full (R\$)
Manpower outsourced	day	24	100.00	2,400.00
Energy	Months	12	300.00	3,600.00
Pro-labor	Months	12	1,000.00	12,000.00
Transport	Months	12	300.00	3,600.00
Inputs livestock	year	1	16,720.00	16,720.00
Formation of mechanized pastures	hectare	2	2,028.00	4,056.00
Implantation of smooth wire fence	km	2	12,900.00	25,800.00
Full				68,176.00

Source: Field research.

In a property with beef cattle is of full importance of mineral supplementation of animals, providing in the trough the nutrients that can not remove from the fodder, it is advisable a strategic supplementation in the dry season, because the growth of the fodder decreases, as well as its nutritional quality, causing the animals to stop gaining weight or even lose weight in this period without supplementation, the consumption of mineralized salt and approximately from 100 g UA⁻¹ [26].

The medicines and inums used in a calf property in the south of the State of Pará are extremely indispensable, as shown in Table 5.

The estimated costs of all expenses on the property from the first year, such as used inums, pasture renovation

and maintenance, installation such as fences, remangas, such as labor, products and energy spent, are present in the Table 5.

Explaining the herd present on the property, and their respective values. Herds are composed of matrices, bulls, heifers, heifers and calves, in addition to the working equidae expressed in Table 6.

Table 5: Acquisition of animals for the breeding system.

Description	Race	Unit	Quantity	Value unit (R\$)	Value full (R\$)
Reproducer L.A	Nellore	cb	2	10,000.00	20,000.00
Mother (+ 36 months)	anelorada	cb	82	3,500.00	287,000.00
Heifer (13 the 24 months)	anelorada	cb	36	2,600.00	93,600.00
Heifer (0 the 12 months)	anelorada	cb	24	2,000.00	48,000.00
Calf (0 the 12 months)	anelorada	cb	13	2,500.00	32,500.00
Horse	3 the 5 years	cb	1	700.00	700.00
Mare	3 the 5 years	cb	1	300.00	300.00
Full					482,100.00

Source: Field research.

The sale of animals in the first (Table 7) and second year (Table 8) will be low, because a large part of the herd are heifers that have become future matrices, in Table 7 are present the animals that will be sold annually as calves

and discards, the expected birth rate, is 60% of the 1° to 3° year, as it is the beginning of activity, there will be no discards between the matrices in the 1° and 2° because they are young animals.

Table 6 Expectation of animal sales in the first year.

Description	Race	Unit	Quantity	Value unit (R\$)	Value full (R\$)
Calf (7 the 12 meses)	Anelorada	Cb	25	2,500.00	62,500.00
Heifer (7 the 12 meses)	Anelorada	Cb	25	2,000.00	50,000.00
Cow disposal	Anelorada	Cb	0	-	0.00
Ox disposal	Nellore	Cb	0	-	0.00
Full					112,500.00

Source: Field research.

In the first year will be sold 100% of the male and female calves, in order to generate more revenue, as well as to facilitate the management of pasture and reform of some pastures, in the second year will be 100% of males

and 70% of females leaving the best to grow and to make replacement for the stock of matrices, which will be discarded later.

Table 7: Expectation of animal sales in the second year.

Description	Race	Unit	Quantity	Value unit (R\$)	Value full (R\$)
Calf (7 the 12 meses)	Anelorada	cb	25	2,500.00	62,500.00
Heifer (7 the 12 meses) *	Anelorada	cb	17	2,000.00	34,000.00
Cow disposal	Anelorada	cb	0	-	0.00
Ox disposal	Nellore	cb	0	-	0.00
Full					96,500.00

Source: Field research. * Sale of 70% of female heifers.

In the 3rd year (Table 9) the matrices began to be discarded at a rate of 10%, where the sale will be composed of 100% of males and 66% of females, leaving

the best for replacement of the matrices that will be discarded.

Table 8: Expectation of animal sales in the third year.

Description	Race	Unit	Quantity	Value unit (R\$)	Value full (R\$)
Calf (7 the 12 meses)	Anelorada	cb	33	2,500.00	82,500.00
Heifer (7 the 12 meses) *	Anelorada	cb	21	2,000.00	42,000.00
Cow disposal **	Anelorada	cb	11	3,300.00	36,300.00
Ox disposal	Nellore	cb	0	-	0.00
Full					160,800.00

Source: Field research. * Sale of 66% of female heifers. ** Sale of 10% of mothers to disposal.

With the improvement of pastures and structuring of the farm, from the 4th year the birth rate will rise to 70%, and sales will be in 100% of males and 66% of females

(Table 10), leaving the best for replacement of the matrices that will be discarded.

Table 9: Expectation of animal sales in the fourth year.

Description	Race	Unit	Quantity	Value unit (R\$)	Value full (R\$)
Calf (7 the 12 meses)	Anelorada	cb	35	2,500.00	87,500.00
Heifer (7 the 12 meses) *	Anelorada	cb	23	2,000.00	46,000.00
Cow disposal **	Anelorada	cb	10	3,300.00	33,000.00

Ox disposal	Nellore	cb	1	6,050.00	6,050.00
Full					172,550.00

Source: Field research. * Sale of 66% of female heifers. ** Sale of 10% of mothers to disposal.

From the 4th year the revenue will stabilize, but it will alternate with that of the 5th year, because in one year will have disposal of an ox and the following year will not have, so it will be successively, as shown in Table 11.

Table 10: Expectation of animal sales in the fifth year.

Description	Race	Unit	Quantity	Value unit (R\$)	Value Full (R\$)
Calf (7 the 12 meses)	Anelorada	cb	35	2,500.00	87,500.00
Heifer (7 the 12 meses) *	Anelorada	cb	23	2,000.00	46,000.00
Cow disposal **	Anelorada	cb	10	3,300.00	33,000.00
Ox disposal	Nellore	cb	0	-	0.00
Full					166,500.00

Source: Field research. * Sale of 66% of female heifers. ** Sale of 10% of mothers to disposal.

Now the balance sheet will be made to evaluate the flows (Table 12) of net cash containing the expenses and revenue so that you can visualize the expenses and revenues of the project.

Table 11: Cash flow.

Year	Period	Investment (R\$)	Revenue (R\$)	Expenditures (R\$)	Cash flow c. liquid (R\$)
2020	0	482,100.00	-	-	482,100.00
2021	1	-	112,500.00	68,176.00	44,324.00
2022	2	-	96,500.00	68,176.00	28,324.00
2023	3	-	160,800.00	68,176.00	92,624.00
2024	4	-	172,550.00	68,176.00	104,374.00
2025	5	-	166,500.00	68,176.00	98,324.00
2026	6	-	172,550.00	68,176.00	104,374.00
2027	7	-	166,500.00	68,176.00	98,324.00
2028	8	-	172,550.00	68,176.00	104,374.00
2029	9	-	166,500.00	68,176.00	98,324.00
2030	10	-	172,550.00	68,176.00	104,374.00

Source: Author himself.

A minimum rate of attractiveness has been adopted (TMA) from 10%, took into account the rate Selic, that's 2.5 [27], project risk, opportunity cost and expected minimum profitability. Thus, the feasibility of the project was calculated (Table 13) and economic indicators (Table 14).

Table 12: Calculated values.

Year	Flow (R\$)	Balance (R\$)	Present Value (R\$)
0	482,100.00	482,100.00	482,100.00
1	44,324.00	437,776.00	40,294.55
2	28,324.00	409,452.00	23,408.26
3	92,624.00	316,828.00	69,589.78

4	104,374.00	212,454.00	71,288.85
5	98,342.00	114,112.00	61,062.64
6	104,374.00	9,738.00	58,916.40
7	98,342.00	88,604.00	50,465.00
8	104,374.00	192,978.00	48,691.24
9	98,342.00	291,320.00	41,706.61
10	104,374.00	395,694.00	40,240.70
TMA			10.00%

Source: Author himself.

The present value of the entries (Table 14) is the sum of all entries at 10% per year, at moment zero. The found value of the Net Present Value (VPL) was of R\$ 23,564.03

this demonstrates that the project is feasible, because this value is greater than zero (0).

Table 13: Economic indicators.

V.P. Entries	R\$ 505,664.03
VPL	R\$ 23,564.03
TIR	10.97%
IL	1.05
Pay-back	6.10
TMA	10%

Source: Author himself.

The Internal Rate of Return found was 10.97%, considered acceptable because it is greater than the TMA. The Profitability Index was 1.05 indicates that it is feasible, because it is greater than 1.

The Payback was of 6.10 this shows us that this project will recover investment in the course of the 6^o year.

Sensitivity analysis (Table 15) is an important ferment, for one observes how much the project and robust, the market variations, in this was analyzed a variation of 10% in revenues and expenses, for more or less, the following case studies were made:

Case one. You don't hear any change in expenses and revenues.

Case two. There was a 10% increase in revenue, as well as expenses.

Case three. There was a 10% increase in revenue, and a 10% reduction in expenses.

Case four. There was a 10% decrease in revenue stemming from expenses as well.

Case five. There was a 10% decrease in revenue, and an increase in expenses of 10%.

Table 14: Net cash flow in reais (R\$) with variation 10%.

Revenue + 10%	Revenue +10%	Revenue -10%	Revenue -10%
Expenditure +10%	Expenditure - 10%	Expenditure - 10%	Expenditure + 10%
48,756.40	62,391.60	39,891.60	26,256.40
31,156.40	44,791.60	25,491.60	11,856.40
101,886.40	115,521.60	83,361.60	69,726.40
114,811.40	128,446.60	93,936.60	80,301.40
108,156.40	121,791.60	88,491.60	74,856.40
114,811.40	128,446.60	93,936.60	80,301.40

108,156.40	121,791.60	88,491.60	74,856.40
114,811.40	128,446.60	93,936.60	80,301.40
108,156.40	121,791.60	88,491.60	74,856.40
114,811.40	128,446.60	93,936.60	80,301.40

Source: Author himself.

As observed in three of the cases observed same with the TMA from 10%, would be economically viable, Case 1, has already been evaluated let's observe the others.

Case 2 (Table 16), where there was a simultaneous increase in revenues as well as expenditure in 10%, how does the VPL was of R\$ 74,099.58 which is greater than

zero, and TIR 12.97% which is bigger than the TMA, and the IL 1.15 greater than 1, in this case the project is feasible.

Table 15: Sensitivity analysis.

Indicators	Case 1	Case 2	Case 3	Case 4	Case 5
	No change	Revenue + 10%	Revenue +10%	Revenue - 10%	Revenue - 10%
		Expenditure + 10%	Expenditure - 10%	Expenditure - 10%	Expenditure + 10%
V.P.Entries (R\$)	505,664.03	556,199.58	639,981.98	455,072.38	371,289.98
VPL(R\$)	23,564.03	74,099.58	157,881.98	27,027.62	110,810.02
TIR (%)	10.97	12.97	16.19	8.85	5.13
IL	1.05	1.15	1.33	0.94	0.77
PB	6.10	5.65	5.02	6.64	7.85
TMA (%)	10	10	10	10	10

Source: Author himself.

Case 3 (Table 16), this is the most desirable to the investor, as there was an increase in the revenue of 10% and decrease in the costs of 10%, with that the VPL was of R\$ 157,881.98 which is greater than zero, TIR 16.19% that and greater than TMA, and the IL and from 1.33 that and greater wants, making the project viable.

Case 4 (Table 16), where there was a fall in both revenue and 10%, in this condition the VPL was of R\$ - 27,027.67 negative, TIR 8.85% therefore less than TMA desired, is the IL 0.94, which is less than 1, in this condition the project would be unfeasible.

Case 5 (Table 16), this is the worst situation analyzed because it hears a fall in revenue 10% and an increase in the costs of 10%, causing the VPL be R\$ - 110,810.02 negative, the TIR was 5.13% and the IL 0.77 that less than 1, in this case the project would be unfeasible.

However, it should be noted that a relatively high TMA was used, only accepting as viable the most profitable cases.

IV. CONCLUSION

In order to make an evaluation of the farm of beef cattle was made levament of the animals, and projection of this, determining the expenses and probable revenues, during the period of 10 years, and analysis of sensitivity of the project, showing that cattle culture and a very safe investment, because even 2 of the cases giving as unfeasible, and due to relatively high TMA, if noted in net cash flow, you can see the profit in all cases.

As shown the beef cattle culture and a robust project, and easy liquids of the assets, if necessary, and that as observed in the field causes a personal satisfaction in the producers, in addition to profitable.

As a suggestion for future work, an observation in the subsequent prices to make a survey of prices during the years, also in different regions within the State, to identify possible bottlenecks in marketing, which would be possible greater profitability to the producer.

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Interaction cultivar environment in soybean for protein yield with different fertilization and sowing dates

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Keywords— *Glycine max*, *stability and adaptability*, *stratification and dissimilarity*.

Abstract— This study aimed at evaluating the interaction cultivar × environments for the oil and protein yield of the grains, in soybeans grown under different levels of potassium fertilization, in two sowing times, in the state of Tocantins. In the agricultural year of 2013/14, were performed twelve soybean cultivars competition trials in Palmas/TO. In each season, each test represented a distinct environment and consisted of a level of potassium fertilization (0, 40, 80, 120, 160, or 200 Kg K₂O ha⁻¹). The experimental design used in each test was a randomized block with 10 cultivars and three replications. Analyses of stability and adaptability, stratification and environmental dissimilarity were performed. Potassium levels and sowing times resulted in differential performance of soybean cultivars. The BRS 333RR cultivar was presented as potentially promising for oil yield and BRS 9090RR for protein. The evaluation tests of soybean cultivars can be performed using low levels of potassium fertilization, providing reduced costs and less contamination of the water table.

I. INTRODUCTION

Amazon soils, especially savannah soils as reference, usually present high acidity and low natural fertility. In this case it is necessary the use of great amount of agricultural inputs to increase productivity of crops. However, the use of agricultural inputs causes water table contamination and soils acidification that result in global warming.

One of these agricultural inputs required by soybean crop is potassium. According to Guareschi et al. [1], potassium is very important in mineral nutrition of

soybean and it is the most absorbed and exported macronutrients by crop.

Chemical composition of soybean can present variations when it is cropped in different environments [2] and it can occur interaction between cultivar and environment (C × E) [3], [4] and [5].

Genetical enhancement programs of soybean aimed at the development of more productive cultivars [3]. On biometrical sense, two approaches are considered: 1) studies of stability and adaptability of different cultivars in which particular responses are taken for each cultivar

under environmental variations. These studies aim at identifying wide or specific adaptability and predictable behavior; and 2) and other related to stratification methods and environmental dissimilarity by interaction cultivar x environment interaction (C x E).

This work aimed at study interaction cultivar x environment about yield of grains of soybean cropped under different levels of potassium fertilizing and seeding periods in Tocantins State, Brazil.

II. MATERIAL AND METHODS

In agricultural year of 2013/2014 twelve competition tests were carried out of cultivars of soybean at Agrotechnological Center of Federal University of Tocantins, Palmas Campus (10°45' S; 47°14' W; e 220 m of altitude), six of them installed in 5th December, 2013 (first seeding period) and six in 23rd January, 2014 (second seeding period – late seeding). Distinct environments were represented in each test in both periods for potassium fertilizing level (0, 40, 80, 120, or 200 kg of $K_2O\ ha^{-1}$). This fertilizer was applied half on planting groove and half 35 days after plants emergence using potassium chloride as source of K_2O .

On the experimental area were collected 20 samples of soil in depth of 0-20 cm that were homogenized and 1 kg of this sample was sent to laboratory for chemical and physical analyses of soil. Obtained contents were pH: 4.1; K: 14.0 mg dm^{-3} ; P (Melich): 1.5 mg dm^{-3} ; Ca: 0.7 cmol dm^{-3} ; Mg: 0.5 cmol dm^{-3} ; Organic Material.: 12.0 g dm^{-3} ; Cation Exchange Capacity: 4.6 cmol dm^{-3} and Base Saturation: 26.7%. These analyses were carried out according to Embrapa's Method of soil analyses [6].

Rainfall and average temperature data during tests were obtained from Meteorology and Climatology Laboratory of Federal University of Tocantins – UFT and presented in Figure 1.

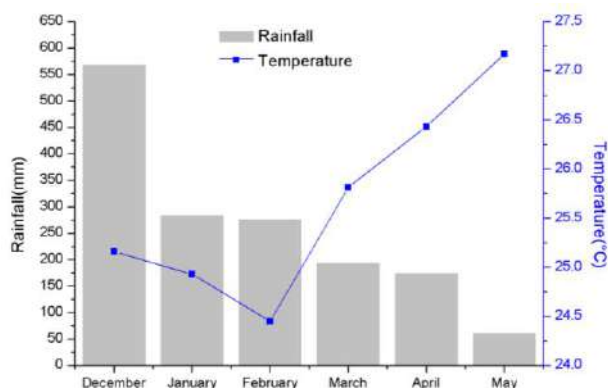


Fig.1: Rainfall (mm) and average temperature (°C) occurred during tests from December, 2013 to May, 2014 on Palmas-TO, Brazil.

Experimental design was randomized blocks with 10 treatments and tree repetitions. Utilized cultivars on treatments were BRS 325RR, M 9144RR, BRS 33871RR, TMG 1288RR, BRS 333RR, P 98Y70RR, TMG 1180RR, BRS 9090RR, M 8766RR, and BRS 8990RR.

In each test, experimental plots were of four runs of 5.0 m of length with spaces of 0.45 m. On harvesting were neglected 0.45 m from border of central runs. Useful area was represented of two central runs of 3.6 m².

After chemical and physical analyses of soil, liming took place using two tons of dolomitic limestone Filler by hectare. Plowing, harrowing and grooving were made after 30 days of soil correction. Seeding fertilization was made by hand with 750 kg ha^{-1} of simple superphosphate that it about 150 kg of $P_2O_5\ ha^{-1}$.

At the moment of seeding, fungicides were used to treat seeds then they were inoculated with strains of *Bradyrhizobium japonicum*. Seeding density was carried out to achieve from 10 to 14 plants by linear meter. After 15 days of seeding it was carried out paring. Pest control, diseases and weed was made when necessary.

Plants of each experimental portion were harvested a week after 95% of mature green beans at maturation stage R8 of Fehr et al. [7] scale. According to useful area of portion was determinates grain yield (weight in kg ha^{-1} after moisture correction of 12%). Then three samples were separated with 100 grams of each portion that were sent to laboratory of Soybean Embrapa in Londrina-PR, Brazil to determinate protein content (%) by Near Infrared Reflectance (NIR) according to Heil [8].

Protein yield (kg ha^{-1}) was obtained by multiplying protein content (%) for grain yield (kg ha^{-1}). To study cultivars behavior in each sowing date, yield data of protein were submitted to individual variance and then to joint analyses in which lesser residual medium square were not different more than seven times from larger medium square [9]. After that, analyses of adaptability, stability, environmental stratification and dissimilarity were made.

Adaptability and stability methods were carried out from Eberhart & Russel [10] and Lin & Binns [11] modified by Cruz et al. [9]. Environmental stratification and dissimilarity were made according to environmental grouping based on the Lin's algorithm [12]. Simple fraction and complex interaction cultivar x environment were estimated according to Cruz & Castoldi [13] method and then Pearson correlation among pairs of evaluated environments.

Averages of cultivars were compared by Scott-Knott test to 5% of significance using GENES Program [14].

III. RESULTS AND DISCUSSION

Individual variance analyses of protein yield (Table 1) presented significant effect from cultivars in all levels of potassium fertilization at two sowing dates. Variation

coefficients (VC) ranged from 4.7% to 10.6%, respectively, in 40 and 120 kg ha⁻¹ at second sowing date (01/23).

Table 1. Protein yield (kg ha⁻¹); cultivars variance (AS_{Treat}); residual variance (AS_R) and variation coefficient (VC) of six competition tests of soybean cultivars in each sowing dates, agricultural year of 2013/2014 at Palmas-TO, Brazil.

Dates	Tests (Kg of K ₂ O ha ⁻¹)	Average (Kg ha ⁻¹)	AS_{Treat}	AS_R	VC (%)
Date 05/12/13	0	1017	218985.6*	5569.8	7.3
	40	1453	124484.1*	11346.2	7.3
	80	1609	35772.4*	16684.4	8.0
	120	1702	81266.5*	12205.8	6.5
	160	1750	83098.6*	17479.8	7.5
	200	1813	121756.1*	13379.3	6.4
	Average	1557			
Date 23/01/14	0	360	28088.7*	437.8	5.8
	40	422	44457.0*	389.2	4.7
	80	454	41993.5*	2002.9	9.8
	120	469	23656.4*	2464.6	10.6
	160	467	29768.2*	1755.8	8.9
	200	498	34367.5*	1337.4	7.3
	Average	445			

^{ns} * = non-significant and significant, respectively to 5% of probability by F test

At second sowing date (01/23) for all levels of potassium fertilization there was a lesser protein yield comparing to first date (12/05), indicating date is unfavorable to soybean crop. This occurrence was expected because of rainfall falling-off on cultivars grain filling (Figure 1). According to Marques et al. [15] rainfall falling-off causes grain productivity fall and then protein yield fall.

Obtained data on this study are similar to Carvalho et al. [5] that verified effect of sowing dates on behavior of soybean in Tocantins State for grain yield.

Joint variance analyses for protein yield in each sowing dates showed significant effects to cultivar, environments and for interaction between them (Table 2).

Table 2. Summary of joint variance analyses for protein yield (kg ha⁻¹) in ten cultivars of soybean submitted to six levels of K₂O in two sowing dates on agricultural dates of 2013/2014 at Palmas-TO, North Region of Brazil.

Variation source	Liberty degrees	Average square	
		1 st Date ⁽¹⁾	2 nd Date ⁽²⁾
Cultivar	9	387792.76*	160273.81*
Environment	5	2574409.34*	69783.05*
Cultivar×Environment	45	55514.14*	8411.53*
Block/Environment	12	31102.88	2326.76
Residue	108	12777.58	1397.95

VC (%)	7.2	8.4
General average	1557.0	445.2

VC: variation coefficient; ⁽¹⁾ Sowing at 05/12/2013; ⁽²⁾ sowing at 23/01/2014; * significant at 5% of probability to F test.

The significant effect of cultivar suggests diversity among the cultivars that can be attributed to the genetic variability, and the effect of environments evidences the importance of the realization of the tests from different levels of potassium fertilization.

Interaction cultivars x environment significant effects indicate changes on fulfillment of soybean cultivars at different levels of potassium fertilization. Analyses of stability, adaptability and environmental stratification justify the importance of protein yield studies.

Variation coefficient (VC) in first and second date ranged from 7.2 to 8.4%, that indicates good experimental accuracy.

Table 3 shows averages and adaptability, stability parameters of cultivars using methods of Eberhart & Russell [10] and Lin & Binns [11] modified by Cruz et al. [9].

Table 3. Parameters of adaptability (β_1) and stability (σ^2_d) for protein yield of soybean cultivar (kg ha^{-1}) obtained from Eberhart & Russell Method [10] - β_1 and σ^2_d ; and Lin & Binns [11] modified by Cruz et al. [9] - π , π_{Fav} e π_{Desf} , on agricultural year of 2013/2014 in Palmas-TO, North Region of Brazil.

Cultivar	Average	Yield of protein				
		Eberhart & Russell [10]			Lin & Binns [11]	
		β_1	$(\sigma^2_d)^3$	π	π_{Fav}	π_{Desf}
First Date ⁽²⁾						
BRS 325RR	1644.4b	1.01 ^{ns}	11.18 [*]	34727.1	6718.7	90743.8
M 9144RR	1478.7c	1.01 ^{ns}	3.76 ^{ns}	78554.2	39178.5	157305.6
BRS 33871RR	1638.8b	0.40 ⁽¹⁾	21.01 [*]	30225.0	44099.6	2475.9
TMG 1288RR	1444.3c	1.00 ^{ns}	5.42 ^{ns}	90533.1	60376.6	150846.0
BRS 333RR	1764.7a	0.80 ⁽¹⁾	11.08 [*]	13271.3	543.2	38727.6
P 98Y70RR	1397.4d	1.37 ⁽¹⁾	3.92 ^{ns}	118564.1	57483.7	240724.9
TMG 1180RR	1513.7c	1.28 ⁽¹⁾	10.28 [*]	67505.4	36920.3	128675.5
BRS 9090RR	1720.6a	1.04 ^{ns}	5.01 ^{ns}	12288.7	6034.2	24797.7
M 8766RR	1650.9b	1.06 ^{ns}	10.71 [*]	26728.0	11889.8	56404.4
BRS 8990RR	1323.2e	1.03 ^{ns}	15.50 [*]	149806.2	114397.2	220624.2
Average	1557.70					
Second Date ⁽³⁾						
BRS 325RR	273.2d	1.27 ^{ns}	0.45 ^{ns}	52537.1	50480.6	56650.2
M 9144RR	533.3a	0.27 ⁽¹⁾	3.85 [*]	5093.6	7569.7	141.3
BRS 33871RR	519.3a	2.71 ⁽¹⁾	2.52 [*]	6213.4	632.9	17374.5
TMG 1288RR	573.3a	1.01 ^{ns}	0.53 ^{ns}	633.4	933.1	33.9
BRS 333RR	478.2b	1.05 ^{ns}	0.16 ^{ns}	7822.0	7539.9	8386.3
P 98Y70RR	384.9c	1.17 ^{ns}	0.84 [*]	22834.7	21967.5	24569.1
TMG 1180RR	481.2b	1.24 ^{ns}	0.24 ^{ns}	7093.7	6604.6	8071.9
BRS 9090RR	460.1b	-0.40 ⁽¹⁾	0.18 [*]	12289.1	17504.0	1859.2
M 8766RR	423.1b	0.76 ^{ns}	0.42 ^{ns}	15524.5	17553.2	11467.3

BRS 8990RR	326.2d	0.91 ^{ns}	0.33 ^{ns}	37052.3	37450.0	36256.8
Average	445.28					

Average followed by same lower case in columns belongs to same group, according to grouping criterion of Scott-Knott on 5% of significance. ⁽¹⁾ Significant to 5% by t test, ^{ns} Non-significant. * and ** significant to 5 and 1 %, respectively by F test; ⁽²⁾ Sowing at 05/12/2013; ⁽³⁾ Sowing at 23/01/2014.

On first date (05/12), considerate the most favorable in this study, five groups of average were made (Table 3). Group of larger average was made only by cultivars BRS 333RR and BRS 9090RR. Cultivar BRS 8990RR presented lesser protein yield.

According methodology of Eberhart & Russell [10] and Lin & Binns [11] modified by Cruz et al. [9] environments classified as favorable were 80, 120, 160, and 200 kg ha⁻¹ of K₂O (Table 1). According to Lopes [16] recommended level for this soil based on chemical analyses would be 120 kg ha⁻¹. After soil analysis better environments are near of recommended potassium levels or superiors.

By Eberhart & Russell Methodology [10], cultivars M 9144RR, TMG 1288RR, P 98Y70RR, and BRS 9090RR presented regression deviations non-significant ($\sigma^2d=0$) indicating predictability (stability) of behavior.

Cultivars BRS 333RR and BRS 33871RR presented average yield of protein above of general average and regression coefficient smaller than one ($\beta_1 < 1$) indicating adaptability to unfavorable environments.

Cultivars P 98Y70RR e TMG 1180RR presented $\beta_1 > 1$ and production average low so they were classified as poorly adapted to favorable environments.

M 9144RR, TMG 1288RR, BRS 8990RR, BRS 325RR, BRS 9090RR, and M 8766RR cultivars presented $\beta_1 = 1$ so they were classified as high adaptability. Among all of them only last three presented average above general average.

According to Eberhart & Russell Methodology [10] only BRS 9090RR cultivar was considered as ideal because presented average superior to general average, regression coefficient equal to unit and regression deviation non-significant.

By Lin & Binns method [11] modified by Cruz et al. [9] cultivars BRS9090RR, BRS333RR, M8766RR, and BRS33871RR presented general π smaller so they were classified of high stability and wide adaptability. First of them was considered highly adaptable by Eberhart & Russell Method [10].

Cultivars BRS333RR, BRS9090RR, BRS325RR, and BRS325RR presented stability/adaptability to unfavorable

environments. Enhance that BRS3371RR also presented adaptability to unfavorable environments according to Eberhart & Russell Methodology [10].

Averages and parameters of adaptability and stability from cultivars for yield protein in second date of sowing (23/01) for Eberhart & Russell [10] and Lin & Binns [11], modified by Cruz et al. [9] are in Table 3.

Cultivars M9144RR, BRS3371RR and TMG1288RR belong to group with greater averages and in group with lesser averages are P98Y70RR and BRS325RR.

For this date tests of 80, 120, 160, and 200 kg ha⁻¹ were classified as favorable environments like in first date of sowing (Table 1). These levels are near or superior to recommended level after soil analyses.

According to Eberhart & Russell method [10] cultivars BRS325RR, TMG1288RR, BRS333RR, TMG1180RR, M8766RR, and BRS8990RR presented regression deviation non-significant ($\sigma^2d=0$) indicating predictability (stability) of behavior.

M9144RR and BRS9090RR cultivars presented regression coefficient lesser than unit and average above general average classified as adapted to unfavorable environments.

BRS33871RR cultivar presented $\beta_1 > 1$ and average above general average so it was classified as adapted to favorable environments.

BRS 325RR, TMG 1288RR, BRS 333RR, P 98Y70RR, TMG 1180RR, M 8766RR, and BRS 8990RR cultivars presented $\beta_1 = 1$ then they were classified with adaptability to wide environments conditions. Among them only TMG 1288RR, BRS333RR, TMG1180RR, and BRS9090RR presented average above general average.

TMG 1288RR, BRS 333RR and BRS 9090RR can be considered as ideal because they presented high average, regression coefficient equal to unit and non-significant deviation regression.

In Lin & Binns method (1988) [11] modified by Cruz et al. [9] cultivars TMG 1288RR, M 9144RR, BRS 33871RR, and TMG 1180RR were classified as high stability/adaptability. Enhance that TMG1288RR and TMG1180RR also presented general adaptability by Eberhart & Russell methodology [10].

BRS 33871RR, TMG 1288RR, TMG 1180RR, and BRS 333RR are stable or adapted to favorable environments, only BRS33871RR were classified as adapted to favorable environments by Eberhart & Russell [10].

Environmental stratification analysis using Lin's method [12] for the first sowing date (05/12) formed only one group with four environments: 5, 6 and 4 environments (Table 4).

Table 4. Grouping of twelve evaluation environments in 10 cultivars of soybean, based to protein yield, in agricultural year of 2013/2014, Palmas-TO, North Region of Brazil using Lin's method [12].

Groups	Environments*	Protein Yield		
		Error MS ¹ (x10 ³)	F _{cal} ²	F _{tab} ³
First date ⁽⁴⁾				
I	5, 6 and 4	4.18	0.98	1.83
Second date ⁽⁵⁾				
I	4 and 5	0.75	1.61	2.08
II	1 and 2	0.76	1.63	2.08
III	5 and 6	0.94	2.01	2.08

¹Error Average Square, ²F Calculated, ³F Tabled to 5% of significance, ⁽⁴⁾ Sowing at 5/12/2013, ⁽⁵⁾ Sowing at 23/01/2014; Environments 1 (0 kg of K₂O ha⁻¹), 2 (40 kg of K₂O ha⁻¹), 3 (80 kg of K₂O ha⁻¹), 4 (120 kg of K₂O ha⁻¹), 5 (160 kg of K₂O ha⁻¹), 6 (200 kg of K₂O ha⁻¹).

Concomitant use of Cruz & Castoldi [13] method and Pearson correlation among environments (Table 5) in each group from Lin's method [12] (Table 4) revealed high percentage of interaction CxE attributed to simple fraction (FS>70%) and high Pearson correlation that confirms groups composition in each date.

IV. CONCLUSION

Potassium levels and sowing dates resulted in different behavior of soybean cultivars.

Stability and adaptability methodologies and environmental stratification and dissimilarity were concordant with each other.

BRS9090RR cultivar presented as potentially promising to protein yield in adequate date.

TMG1288RR cultivar presented as potentially promising to protein yield in late date.

Evaluation tests of soybean cultivars can be realized using low levels of potassium fertilization with cost reduction and less water table contamination.

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4DGAP: New tool for multidimensional impact assessment and guide to certification programs for Good Agricultural and Environmental Practices

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Keywords— Sustainability, Environmental
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agricultural quality.

Abstract— Food markets are increasingly demanding the implementation of good agricultural practices programs (GAP) in the public or private sectors as a way to guarantee the sustainable and responsible production of safe food. Due to the large number of GAP programs being implemented, producers are often required to participate in several of them to comply with the demands coming from diverse buyers in different target markets; as a result, even though the majority of certificate requirements share factors in common, the costs of implementation and evaluation increase. In this context, a tool was created to analyze and manage multidimensional risks in agriculture (4DGAP tool) (evaluation of the GAP in four dimensions), developed through an alliance between Embrapa and IICA proposing methodological bases that would support the preparation and updating of indicators linked to the GAP programs, facilitate interplay between the different certification programs and likewise between programs and the producers, agribusinesses and governmental agencies that use them. In addition, its objective is to contribute to the reorganization of all kinds of rural farms, based on a concept of property planning in keeping with the technical and environmental parameters needed to comply with the principles of sustainable development.

I. INTRODUCTION

Since the end of the 90's, GAP programs have become common and even mandatory in the food production process, especially in relation to food destined for fresh consumption (Amekawa 2009, Mattos et al. 2009). Over time, it has become necessary to understand the reasons for the success and failure of these programs so their effectiveness can be improved. (Srisopaporn et al. 2015).

A lack of specific tools to evaluate and monitor GAP programs motivate the need to find options that serve as a basis for their development. In some cases, simple monetization of the systems' results has been used (Mandarino et al. 2019); however, the programs contain numerous variables that hinder a complete financial assessment.

With few exceptions, GAP programs are based on the triad of food safety, worker safety (or sustainability of the

activity) and environmental protection, which has gradually evolved to resemble the makings of a system to assess the impact and environmental management of rural farms (da Cruz et al. 2006, Sabbag 2008, Blasi et al. 2016).

Although in the majority of cases the use of indicators to evaluate sustainability generates an incomplete description of a very specific problem, when applied to highly subjective matters, such as certification of agricultural quality, it can become a valuable tool to reduce the realm of speculation (Binder et al. 2010, Coteur et al. 2016). Mendoza and Prabhu (2003) recommend using these indicators, since they make it possible for the different variables to interact in a holistic manner, including economic, environmental, biological and physical factors, hence allowing the condition of the agroecosystem to be evaluated and described.

Notwithstanding the above, the difficulty of implementing a system depends on the selection of a certain number of socioeconomic, biotic and abiotic parameters that will serve as points of verification: having too few elements can result in a certification program that is too weak for the interested target audience, while an excessive number of elements can decrease the number of producers who are willing to participate in the program (Girardin et al. 2000, de Figueirêdo et al. 2010). Currently, there are several formulas to define the indicators, but even today the premise is that the indicator must be representative, and where possible, multidimensional (Bertocchi et al. 2016, de Olde et al. 2017).

While a system of GAP and good environmental practices is made up of a series of indicators of varying dimensions with different levels of importance where necessary, (Walter and Stützel 2009), generally speaking evaluating compliance with good practices is carried out at a global level, without regard for the size of each dimension or the interrelationships between them, which makes way for its implementation across all components of the chain, from the supplier of inputs to the consumer at the point of sale (Amekawa 2009). Compilation and data management of all the components are crucial, since they form the base for tracking the system and ensuring the chain of production/manufacture and stewardship of the products and inputs.

According to Rodrigues et al. (2003), Hayo et al. (2007) and Van Passel & Meul (2012), the typical restrictions associated with the use of indicators in environmental (or sustainability) analyses result from the lack of detailed information about choices made during the planning process, which is when methods of selection, compilation and data grouping are defined that will form the basis for the subsequent use of indicators.

Given the current low cost of compilation and data storage systems, these activities no longer pose an obstacle and have become key steps in conducting a thorough evaluation of certification programs and the structuring of management systems geared toward their improvement. Subjective bases for the data sets compiled over time have been abandoned, which allows the databases to be studied and analyzed, especially where it relates to rural farms. Therefore, as these databases grow, the systems of evaluation can also operate in a timely manner, assessing advances in the good practices program being implemented on the farm over time.

Another feature of the good practices programs which facilitates adoption of these evaluation and management processes is that compliance evaluations are carried out based on simplified verification lists which contain elements that are structured in keeping with a descending standard and scientifically based ceiling values that require integral completion in a binary form (yes or no); this avoids the occurrence of non-parametric subjectivity that is based on the evaluator's experience (Hayo and Van der Werf 2002, da Cruz et al. 2006). When technoscientifically derived binary systems are used in evaluation processes involving verification, these binary systems are more restrictive compared to those that adopt partial compliance as an option, since by selecting the indicators and parameters that must be completed, the system will be satisfied only when it achieves full completion of the key points of the program, avoiding exchanges and interpretations that could affect the environment and go against the objectives proposed by the system creators.

Some GAP evaluation systems can use a combined standard that allows some elements of partial compliance to be included; in this case, the elements of mandatory compliance are clearly delineated in the binary evaluation and likewise the elements of partial compliance for purposes of their improvement (Amekawa 2009), including when they are evaluated with a certain degree of subjectivity depending on the evaluator (percentage, descriptive and qualitative, among others). However, what will define their approval in the evaluation will be the full presence of mandatory elements in the system, which emphasizes the importance of binary evaluation in the verification list process.

Due to the expansion of global trade, the difficulty of harmonizing several GAP certifications programs, international recognition of many private and public certification "seals" and the need to expand client base, producers end up contracting several certification programs so they can sell their products to various buyers in different countries. This situation drives up the cost of

GAP programs, as a result of the multiplication of compliance evaluation costs and the corresponding audits.

There is no interface between the certification programs, so rural producers and the certifying entities find it difficult to understand that several certifications share many requirements in common for which compliance is needed. Therefore, it was necessary to design an integrated evaluation tool, based on simplified indicators, that would analyze government and private certification programs and show the requirement dimensions in which the producer with. It is within this context that the 4DGAP tool arose, aimed at evaluating multidimensional impacts and steering the direction of GAP and good environmental practices certification programs.

The 4DGAP tool was developed through an alliance between Embrapa and IICA with the aim of establishing methodological bases to continue preparing and updating indicators that would facilitate the interface between different certification programs and producers, agribusinesses and government agencies. It not only facilitates assessing compliance with commercial demands for food safety, but also the progress made in reorganizing rural farms in each country in keeping with technical and environmental parameters required to meet the precepts of sustainable development.

II. METHODOLOGY

The 4DGAP tool consists of a matrix of questions and binary responses (yes and no), created on a spreadsheet (MS Office Excel, Linux, Google, etc) that uses the same matrix mechanism. In order to build the questionnaire, information (metadata) is taken from the checklists of the main certification programs available on the market (GlobalGAP, Produção Integrada, TESCO Nature's Choice, BRC/GFSI, etc.), whose data originate from collections in the field; added to this is the interpretation of the origin of each verification element as needed, which transforms them into indicators (Amekawa 2009, Mattos et al. 2009).

Initially, the verification items in these programs were analyzed individually, point by point, selecting those that had the greatest capacity to represent the multidimensional character of the production context and the safety of the end consumer.

As a result, the 4DGAP tool was configured as a matrix with five columns (Axis Y¹): the first column contains the indicators in the form of questions, just as they would appear on the questionnaire sheet, and the rest of the columns correspond to each of the following

dimensions: environmental care, worker/farmer safety, food safety and economics. The eleven groups of indicators were distributed along the length of the matrix (Axis X¹_n) as shown in Fig. 1.

Detail of the checklist		Measured dimensions			
1.	Farm history and management	Environment	Worker	Food Safety	Economics
1.1	Management of physical space of the farm - Total	0	0	0	0
a)	Does the producer have the ability to read and interpret a map or sketch of the farm?	0	0	0	0
b)	Does the producer have at this time a map or sketch that allows viewing the farm, production areas, facilities, roads, water resources, forest, etc.?	0	0	0	0
c)	If necessary, does the owner have the conditions to design or help design a map or sketch for planning the property?	0	0	0	0
1.2	Production site management - total	0	0	0	0
a)	Does the farm have a risk map for chemical, physical and biological hazards for production and storage?	0	0	0	0
2.	Propagation material				
2.1	Health and quality of propagation material - total	0	0	0	0
a)	Are the propagation materials certified for Health and Quality?	0	0	0	0
3.	Soil and other substrates management				
3.1	Soil maps - (Governmental indicator) - Total	0	0	0	0
a)	Is a soil map available for the region?	0	0	0	0
3.2	Soil analysis - Total	0	0	0	0
a)	Do you perform soil analysis on the farm?	0	0	0	0
b)	Does the producer know how to take the soil samples or does he have technical assistance?	0	0	0	0
c)	Does the producer know how to interpret the result of a analysis of his subjects?	0	0	0	0

Fig.1: Format of the 4DGAP matrix, where the indicators are placed on the horizontal lines and the evaluated dimensions in the columns. Source: Díaz et al. (2017)

According to Díaz et al. (2017), the groups of indicators selected following the guidelines of Hayo and Van der Werf (2002) were derived from analyzing the checklists of GAP certification programs and the matrixes of the previously evaluated impact evaluation, resulting in the following elements: a) farm history and management; b) propagation material; c) soil and substrate management; d) fertilization; e) water management; f) crop protection; g) animal presence on the farm; h) hygiene and health; i) transportation; j) waste management and polluting agents; and k) training.

In each of these groups there should be at least one representative indicator occupying the matrix line (Axis X¹_n), without setting a maximum number as a limit, consistent with how it is represented in each dimension.

Subsequently, the 4DGAP tool was tested for its representativeness and the validity of the selected dimensions and indicators, with the support of, and analysis by government experts from several countries, field technicians, rural producers and users of safe food production and environmental assessment programs through meetings, interviews, and applications of the system on a phased experimental basis over a period of three years.

The data entry page of the questionnaire is found in the operative section of the 4DGAP matrix; it consists of a closed questionnaire where each line must be answered with a binary response: yes (1.0) or no (zero), according to

the user's compliance with the questions presented in the checklist, which generated the indicators listed in Y_1, as shown in Fig. 2.

Fig.2: Partial sample of the data entry questionnaire, with instructions on how to complete the columns on the right.

Source: Díaz et al., 2017.

Therefore, the indicator assumes a value of zero when the location being analyzed does not comply with the element of the checklist, or it complies partially, and a value of 1.0 when it complies fully. This eliminates the difficulty of assessing disparate indicators, since there is no comparison between them, just the verification of full compliance. It is fitting to emphasize that each indicator must show compatibility and the consequent score with at least one or more dimensions under analysis in the columns on the program worksheet. Therefore, the sum of the cells in each horizontal line should range in value between 1 and 4; the higher the value, the less specific and more representative it becomes.

The final results are shown on the results and graphics worksheet, where a numerical table is generated to show the results of the different indicators, together with a radial graph to show the overall verification of the analysis and the final score, as seen in Fig. 3 and 4.

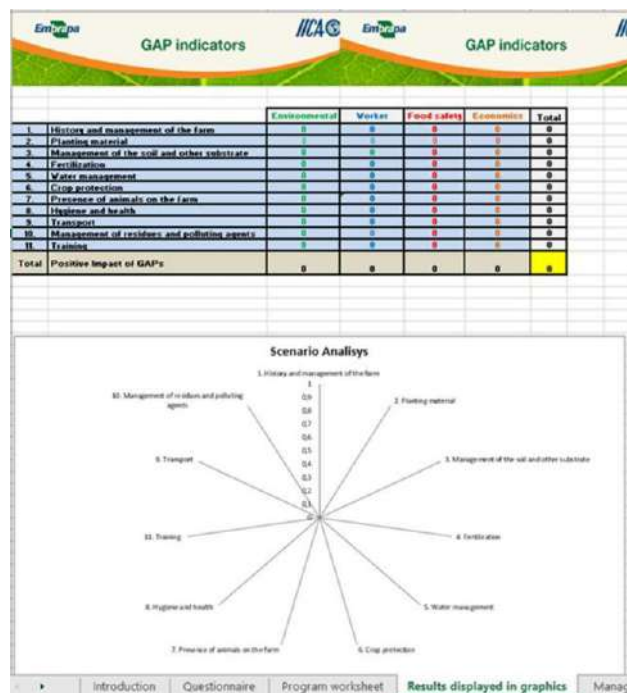


Fig.3: Presentation of the output data in numerical and graphical form, with the corresponding quantitative axes for each group of indicators for the general overview.

Source: Díaz et al., 2017.

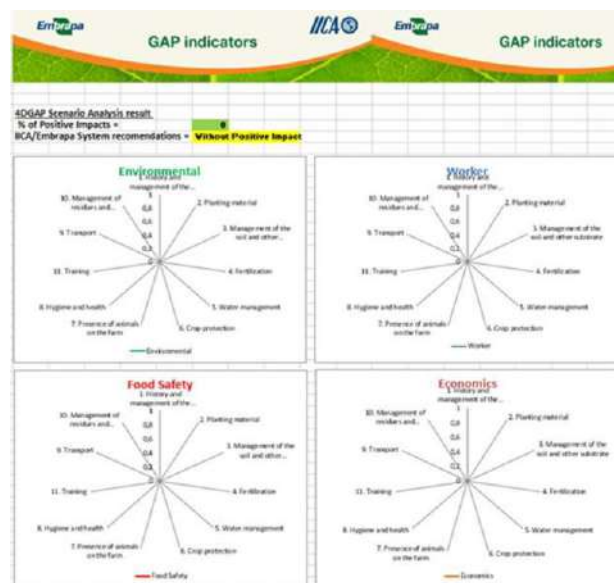


Fig.4: Presentation of the scenario analysis result, and a general overview for each of the individually analyzed dimensions. Source: Díaz et al., 2017

The scoring produced by the tool is organized in three stages:

1. The numerical standardization of the sum of the columns in the dimensions for each group of indicators, where the sum of the values in the dimension column is divided by the maximum number of group dimension

indicators (Idg) contemplated in that dimension (Equation 1), which allows for a normalized response to be generated between zero and 1.0.

$$Idg = (n \text{ marked indicators representative of the dimension} / nT \text{ total indicators representative of the dimension in the group}) \dots\dots\dots(1)$$

2. The summation of the indicators, first on the Y axis, in the form of dimensions in each group, where, in a situation of perfect compliance, the index reaches 1.0 and nears 0 where non-compliance with the demands on the interviewees' control lists is detected, and then on the X axis, where, if there is full compliance with the requirement of the indicator group, a score of 4.0 is obtained, which decreases when the elements in the control list under analysis are not fulfilled.

3. The summary phase forms the basis of the farm's planning and environmental management phase, where it indicates to the decision maker the areas that are weak and the extent of measures to be taken.

4. Once the final sum of the columns and rows is obtained, a single numerical value is generated so that the general matrix score varies between 0.0 (zero) and 44.0 (Equation 2). The tool is reset using this value, which is then divided by the total value (44) and multiplied by 100, which generates a positive impact value (PI%) in the form of a percentage where values closer to 100% represent environments with better socioeconomic and environmental conditions and a greater degree of compliance with the food safety requirements compared to scenarios with values closer to zero, where the positive impacts detected would be less.

$$PI (\%) = (\Sigma \text{ Group indicators and dimension})/44 \cdot 100 \dots\dots\dots(2)$$

This simplified value facilitates the analysis of the overall evolution, and broken down by areas, of the same farm over time, as well as the comparison between the analyses of different farms, validating efforts to improve the production system and monitoring the individual, group and regional process. Therefore, the tool could appear in three different scenarios:


1. The maximum value of 100% would mean the "maximum positive impact" has been achieved and the sustainable development prerequisites have been fulfilled by applying all the suggested agricultural and environmental practices, hence it should stay productive

2. A value of 0% (zero) would signify the worst case, classified as "no positive impact"; because of this the system would register a high level of environmental degradation, which means no actions were identified in the unit being analyzed that could generate positive impacts

and the grower will need to implement a recovery plan for the farm, a status which reflects in the system as "Apply environmental management".

3. Any intermediate value between the two values above would mean the grower must execute a recovery plan for the farm, classifying it with the status of "Apply environmental management".

The final item constitutes a guide to resolve the problems described in the analysis generated after the user completes the 4DGAP. It applies the principles of environmental management as it relates to the general surroundings of the farm, including the social, economic, productive and ecological dimensions present in the productive space. If the index generated by the 4DGAP is other than 100%, it means the analysis detects risks in at least one of the analyzed dimensions on the farm area being investigated, but they can be mitigated using measures based on the following problem-solving matrix: a) What was the initial problem? b) What initial measure can be taken? c) What are some of the problems that occur after taking the initial measure? d) What can be done to resolve the resulting problems and for how long? This process is shown in Fig. 5.



B) Example of a management matrix for the actions of the producers...

Item	Initial Problem	Initial action	Problems found (limitations)	Mitigation (including execution time)
1.1-a	The producer is not able to read or interpret a map or sketch of the farm	Find out where he can learn or receive training in map and sketch reading and interpretation	There is no training available in that aspect of knowledge within the region	Find this type of training or training in locations near to the farm and, if possible, between production cycles
			The producer does not have financial resources to pay for training	Mobilize groups of producers and request training from the corresponding authorities or the association to which they belong
			The producer cannot leave the property for reasons of logistics or lack of labor for carrying out the daily activities	Make an immediate request to the corresponding authorities or to the association to which they belong for training on the property or distance training, if possible

em worksheet Results displayed in graphics Management matrix - government Management matrix - producers Qu

Fig.5: Example of an analysis performed in the risk management matrix of the 4DGAP system performed on a situation found in an analyzed rural property. Source: Díaz et al., 2017.

This matrix, which is based on similar risk analysis systems found in administrative and environmental processes applied to agriculture (Campos and Melo 2008, Garza-Reyes et al. 2018, Huber et al. 2018), is filled out freely, since this is the way in which users present the problem, realize it exists, dedicate time to study a solution and think of ways to resolve it while taking into account

their technical and economic limitations and seasonal constraints.

Given that the problem-solving matrix is a practical exercise that is under development, it can change over time as problems are solved, as they are replaced by others and as more complex solutions arise than what were initially proposed.

III. APPLICATION AND CONSIDERATIONS

After its final structuring, the 4DGAP was evaluated in the field between 2016 and 2018 through its application among a group of producers participating in different private or public certification programs involving different crops in Brazil (Brasília Qualidade no Campo, Programa de Alimentos Seguros y Produção Integrada/Brasil certificado) and Costa Rica (GlobalGAP and BPA-MAG), with subsequent interview, using a questionnaire with open answers, as a way to test whether rural producers understood it, gauge its acceptance among them, and verify both the ease with which technicians trained in its use could implement it and the tool's robustness in relation to different production and certification systems (see Table 1).

Table 1. Application of the 4DGAP tool by country, the certified quality program, the number of producers and type of product.

Country	GAP Program/ certification seal	Number of producers analyzed	Type of product certified
Brazil	Brasília Qualidade no Campo ¹	1	Vegetables
	Produção Integrada/Brasil Certificado ²	2	Fruits/ viticulture
	Programa Alimentos Seguros (PAS) ³	20	Fruits/ viticulture
Costa Rica	GlobalGAP ⁴ /BPA-MAG ⁵	1	Fruits
	BPA-MAG ⁵	3	Vegetables
	BPA-MAG ⁵	1	Strawberries, mulberries

¹ Brasília Qualidade no Campo is an official program of the Government of the Federal District of Brazil.

² Produção Integrada and the Brasil Certificado seal constitute the Brazil government's official GAP

certification system; it is administered by the Ministry of Agriculture and is recognized internationally.

³ The "Programa Alimentos Seguros" and the PAS seal constitute a private certification program used by producers in Brazil; it is recognized by multinational companies that purchase their products.

⁴ GlobalGAP is a private certification program used by producers worldwide and it is recognized by multinational companies that purchase their products.

⁵ Program BPA-MAG is the Government of Costa Rica's official GAP certification system; it is administered by the Ministry of Agriculture and Livestock (MAG).

As the field surveyors were applied, the refinement of the 4DGAP was also made, which started to be considered adjusted from the lack of new demands on the part of technicians and producers. When applied by different people under different circumstances, the robustness of these evaluation systems proves interesting for decision-makers (Shackelford et al. 2019) whether it is the decision-maker is the rural producer who needs monitoring and direction to manage the particular circumstances of his farm; the certification program managers, who would have a clearer vision of the program's evolution; or the public agencies that would obtain feedback both on their projects with the aim of supporting these programs or the environment, and on the management of resources and efforts in this regard.

According to Mauchline et al (2012) and Coteur et al. (2016), in order to guarantee the robustness of the system after its launch, interviews to generate farm analyses were conducted among different people and different agencies, ranging from the producer who is directly involved in production and the company's technical assistant, to the company that receives and processes the product. Therefore, besides the 4DGAP team that created the tool, other technical advisors and extension officers were trained to apply the method and evaluate impressions concerning the advantages and challenges of implementing the tool, the interpretation of results and the guidance given to producers.

The first impression of the effectiveness of the 4DGAP tool came from the group of developers who applied the tool to different certification programs: whether the programs were complex or simple, they did not encounter any problems in terms of adaptability. Since the indicators' core principles were represented across the different programs and given that there were no unclear questions that would be subject to interpretation and therefore put

the evaluation system at risk, the questions were answered in an efficient manner.

With regard to the programs that had the largest number of respondents, we made sure to send the interviews to trained technicians in order to obtain external input. According to the responses gleaned by these teams, it was verified that although users initially thought the questionnaire was long, once it was being applied it was possible to discuss and find solutions to many of the problems that were detected; later on, this would facilitate the work of technicians as they supported producers, turning it into a positive factor.

The tool was considered useful for revealing problems that often were not considered or were not obvious to farmers, which allowed targeted work to be done after the planning phase.

Another positive factor was the numerical visualization based on the final classification that resulted from the farm's evaluation and the partial values that ensued from the analysis, which shows the exact areas in which the producer could attain maximum results and investment options to reach the goal. This opened up the opportunity to assess the need for significant financial investment to reduce the wait time or select and fulfill critical high impact factors with less resources and time. As a result, the producer was able to face head on the difficulties that came with environmental management in his area of production, since he had a better understanding and a better basis for making decisions.

One advantage of the tool that was mentioned was the fact of having a group of producers who were using the same certification program, since this fostered an environment of internal competition to attain the qualifications endowed by the tool, making it possible to compare producers and generate the sense that improving is a requirement.

Finally, something that caught the attention of the technicians who applied the questionnaires and who worked directly with the group of producers is that the model allowed them to have a temporal view of the process, as they started to follow the evolution of sustainability standards and environmental impact, as the producer met the demands generated in the check list and then organized in the management matrix generated by the producer. These developments were previously restricted to eventual descriptive reports, when required by the certification programs, otherwise information would be lost to the process.

In addition, since 4DGAP tool facilitates continuous transformation, increasing or decreasing ratings both globally and at the level of indicators, it was easy for

farmers to implement planning and impact verification to the extent they were re-evaluated.

IV. SAFETY FOOD AND PUBLIC POLICY IMPLICATIONS

For local governments, the intrusion of foreign certification systems, private or not, usually focused on the export of local agricultural products, affects the organization of the official food security system in the country.

The existence of a tool that allows assessing and juxtaposing the requirements of the different certification systems operating in a country or administrative region, allows the opening of discussions regarding a policy of equivalence between the different "quality seals", whenever they depart the common basis of assessment through BPAs.

Likewise, if this tool has an advisory system for organizing the productive environment in the form of a matrix of risk analysis and management of the productive environment, it also facilitates the planning of agricultural policy for the region or by culture, since the bottlenecks for the implementation of good practice systems, generally required for products focused on exports, they can be planned based on real demands, avoiding unnecessary expenses with under or over dimensioning efforts, resources and manpower.

Therefore, the 4DGAP system offers an organizational advantage to support policies to support the agricultural sector of a specific country, region or productive sector, whenever they need to discuss the possibility of adjusting the official and unofficial certification systems in force for the local situation, facilitating the work of the production chain, product buyers or governments.

V. CONCLUSION

The 4DGAP tool was designed to conduct an integrated evaluation of the various certification programs (official or private) available on the market. In the sample analyzed, neither developers nor technicians who were subsequently trained to implement it encountered any difficulties in understanding or applying it to the various programs.

The model provides the ability to monitor the improvement in the sustainability of the certified production system over time, maintaining the record of actions performed in the past and the planning of those that will still be necessary to achieve the optimization of the

process, minimizing the impacts environmental, economic and social aspects of the analyzed production system.

After the initial impact that the evaluation, and as interviews were being held, a positive, collaborative attitude ensued among them during the analysis and discussion for solutions.

The annotation and graphics system helped the producers in visualizing the existing problems in the evaluated areas, as well as in the application of the environmental management matrix to solve the problems, with the support of technical advisors and extension staff, which can also be useful in a process of agricultural government planning in determining the bottlenecks of agricultural policy for the region or the productive chain analyzed.

The 4DGAP tool can be useful for analyzing the effectiveness of GAP programs, specifying which aspects or indicators reveal strengths or weaknesses and, at the same time, can also be used to assess the efficiency of different programs, whether private or official, allowing the harmonization among them, as a form of agricultural policy, if necessary.

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Construction process of a Virtual Learning Environment in Adult Cardiopulmonary Resuscitation

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Keywords— *Cardiopulmonary Resuscitation. Computer Simulation. Educational Technology. Education Nursing. JavaScript.*

Abstract— *There are still considerable variability in survival rates regarding Cardiopulmonary Arrest (CA) that cannot be attributed exclusively to the patient characteristics. The lack of knowledge about the theme by professionals and academics is a graduation consequence. This way, graduating professionals able to operate front CA situations is believed to be a primordial attitude to increase patients' survival chances. To do so, there are digital strategies that can be used, one of them is the Virtual Learning Environment. Thus, this paper's objective is to develop a virtual interactive educational proposal about cardiopulmonary resuscitation care on adults. This is an applied research, which led to the development of a technological product – the elaboration of an educational proposal applied to Virtual Learning Environment. Then, it took place the cyclic phases of conception and planning, development and implementation, according to procedures and evidence reported on previous studies. The Virtual Learning Environment was called “Training in Basic Life Support (BLS)”, and has seven modules: “Historical Aspects”, “Basic Life Support”, “Epidemiology”, “Concepts”, “Anatomy and Physiology”, “Algorithms”, “Simulation and Questions”. The illustrations, formatting and layout were built by integrating both language programming technologies: PHP and JavaScript. The results of the evaluation, made by the academics, about the VLE usage pointed that opportunities to self-learning were created and the available resources in the environment were useful to support learning. It's necessary to comprehend and incorporate the Virtual Learning Environment as an efficient educational tool, and get aware of this knowledge as a strategy to add up new experiences and values to teachers' practice.*

I. INTRODUCTION

Despite significant advances in care for victims of cardiorespiratory arrest (CA), there is still considerable variability in survival rates that cannot be attributed exclusively to the patient characteristics. In order to increase the chances of survival of CA victims, allowing these individuals to receive high quality care, training in

Cardiopulmonary Resuscitation (CPR) must use educational principles supported by researches that turn scientific knowledge into practice¹.

It is reported that professionals and academics from the health area do not possess satisfactory scientific knowledge, either theoretical or practical, regarding CA/CPR. This lack of knowledge, partially, is a

consequence of the graduation, in which the approaches of that theme, when occurred, are just a few and superficial, so, insufficient to provide the solid knowledge acquirement to the action in front of a CA victim². This way, thinking about the graduation of professionals able to operate front CA situations is believed to be a primordial attitude to improve the quality of assistance, increasing patients' survival chances^{2,3}.

For that, there are Digital Information and Communication Technologies (DICT) strategies that turn possible innovations on the educational process, articulation between theory, practice and research. These technologies can be applied from the starting teaching of the student until one's insertion at the profession, as well as at the continuous professional development, determining a new pedagogical practice⁴.

Some studies have shown that technological resources applications, such as Moodle, apps, social networks, forums and Virtual Learning Environments (VLE), provide the acquirement of information and cognitive skills to carry out Nursing procedures, increasing safety and self-confidence about the acting.

Considering the exposed, it was intended to develop an educational proposal about CA assistance in adults, applied at a VLE, which will become available to public and private Higher Education Institutions and to the whole society. This theme was chosen considering the scarcity of didactical material about the subject on this perspective, and the necessity of nurses to be trained, through specific knowledge, safety, abilities and skills, to act in emergency situations that offer life risk. It's believed that, through VLE, it's possible to add meaning to undergraduate nurses' daily practice, stimulate autonomy, such as promote professional actualization.

Due to the existence of numerous possibilities and potentialities of different technological resources, planning and analysis of new ways to teach and learn are important, from the establishment of clear educational goals and the abilities and competence on cognitive, psychomotor and attitudinal spheres, suiting the use of computer to objectives proposed to teaching. Therefore, the objective of this study was to develop an interactive virtual educational proposal about cardiopulmonary resuscitation in adults.

II. METHOD

Applied research, which led to the development of a technological product, regarding the elaboration of an educational proposal applied to Virtual Learning Environment. To reach it, it took place the cyclic and

interactive phases of conception and planning, development and implementation, suggested by various researches^{5,6,7}.

This paper is part of the dissertation "Teaching of Basic Life Support to Students of Nursing Graduation Course", linked to the Post-Graduation Program *Stricto Sensu*, Professional Master Degree in Health on Amazon Teaching, from the University of Para State (UEPA). The project was submitted to the Research Ethics Committee from the Nursing Graduation Course of UEPA, Certificate of Presentation to Ethics Appreciation: 62000616.2.0000.5170, with approval number 1.897.505, on 01/25/2017.

III. RESULTS

Conception and planning

Construction of the educational technology: website/VLE – The elaboration of educational technologies, by own comprehension, demands scientific evidences; definition of the educational technology objective, goals, selection of the target-public to whom the technology's destined, type of material (guideline, folder, flyer, manual, app, blog, website etc.), themes, illustrations and language; demands action planning⁽⁸⁾. From this, it was built a Virtual Learning Environment named "Training in Basic Life Support (BLS)", highlighting the track among texts and pictures and the outcome (final version). It is found hosted on the link: <https://profmaiconnogueira.wixsite.com/capacitacaosbv>

Concerning the scientific evidences to the VLE construction, the search arose from the studies of Bellan (2006)¹¹ and Gonçalves et. al (2010)⁴, as the state of art about Teaching of Basic Life Support in Nursing Graduation, allowing the target-public to be decided. To define the type of technology, a search and reading of scientific articles related to the theme was made, listing some papers that were close to the studied subject^{5,6,7,9,10}. This result was crucial to define the type of technology and its production.

Development

Track among texts – the scenario provided by the DICT, through the transformation of various communication ways into digital information, offers the pedagogic option by the virtual environment, optimizing, that way, the relation between Nursing professors and their students, in the means that this new setting turns possible a reflection about educational practices⁵.

By this sight, the investigation of content to be inserted in the technology started with the diagram construction of themes chosen by the author to VLE

elaboration, what is meaningful to be presented (Figure 01).

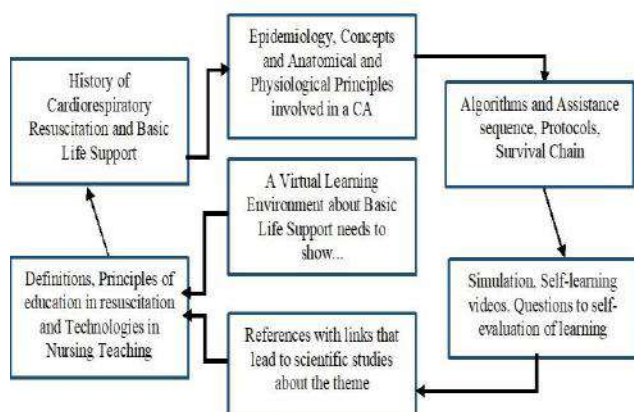


Fig.1: Diagram – themes on author's experience to the VLE elaboration

Source: Personal Collection, Belem, Para, 2021.

Such reasoning, based on professional experience and sustained by current scientific literature, subsidized the construction of “VLE – Training in Basic Life Support (BLS)”, according to the recommendations of the International Liaison Committee On Resuscitation (ILCOR) and the scientific consensus of American Heart Association (AHA, 2020). The contents approached in the educational technology were selected by relevance to guide BLS Teaching, in accordance to the educational principles of Resuscitation Science Consensus proposed by AHA (2020)¹.

Track among images – VLE's illustration is a thought-provoking stage, considering that the interpretations are diverse. The track about the images occurred from the main themes definition, getting started by the cover pictures (Homepage/ Figure 02).



Fig.2: Representative figure of Teaching Environment in BLS Image selected to represent the Teaching Environment of CA maneuvers – cover (Homepage).

Source:

<https://profmaiconnogueira.wixsite.com/capacitacaosbv>



Fig.3: Algorithm of assistance on BLS, responsiveness evaluation.

Source: Personal Collection, Belem, Para, 2021.



Fig.4: Algorithm of assistance on BLS, pulse verification and chest compressions

Source: Personal Collection, Belem, Para, 2021.



Fig.5: Algorithm of assistance on BLS, breathing evaluation and permeabilization of airways

Source: Personal Collection, Belem, Para, 2021.



Fig.6: Algorithm of assistance on BLS, ventilation technique e use of the Automated External Defibrillator (AED).

Source: Personal Collection, Belem, Para, 2021.



Fig.7: Algorithm of assistance on BLS, position of recovery.

Source: I Guideline of Cardiopulmonary Resuscitation and Emergency Cardiovascular Cares from Brazilian Cardiology Society¹².

Within the VLE, some images were inserted, which represent teaching/training environment, algorithms, survival chain, chest compression techniques, permeabilization of airways, ventilation, use of AED, airways devices and safety position.

Implementation

The educational technology/VLE – final version – The educational technology has seven modules: “Historical Aspects”, “Basic Life Support”, “Epidemiology”, “Concepts”, “Anatomy and Physiology”, “Algorithms”, “Simulation and Questions” – in what the student will be able to obtain individualized learning, being possible to access each module in independent manner, forwarding and going back whenever needed.

The images of VLE are photographs taken by the authors themselves, at the Nursing School Magalhães Barata, University of Para State, during classes of the curricular component “Nursing at Urgency and Emergency” and courses ministered about BLS, after

authorization of image usage from the involved people. Other images were chosen from the internet (sources identified under each illustration).

The illustrations, formatting and layout were the result of an effort from a computer engineer, who did the website construction. The VLE was developed by integrating technologies as web programming languages PHP: Hypertext Preprocessor (PHP)¹³ and JavaScript¹⁴.

IV. DISCUSSION

In Brazil, Nursing has used VLE in its courses, as it is shown by the literature review in thematic areas of medicine administration, wounds treatments, Basic and Advanced Life Support and material sterilization. At the international scenario, VLE is used by this profession too and, recently, Blackboard.5 supported Nursing students learning in a module of Human Anatomy and Physiology⁹. From that, it was decided to create a free easy to use VLE, which would satisfy the needs of Nursing undergraduates.

The results of the evaluation made by the academics about this intervention pointed that opportunities to self-learning were created and the available resources in the environment were useful to support learning, ensuring bigger knowledge and ability to the students. These results are similar to other health areas, which have used VLE and its resources too – to reduce the number of formal classes’ hours, increase students’ enthusiasm by the use of multimedia materials and provide interactive learning⁹.

To assure the quality of educational technological information put in this VLE, the recommendations evidenced in the literature were followed, in which is highlighted the need to make researches in formal reliable sources, such as: books, technic articles and interviews with professionals of the area, besides photographical registers, recordings and direct observations of the reality wanted to intervene⁸.

Moreover, PHP is one of the most used languages on the Web. The main difference, compared to other languages, is the capacity that it has to interact with the Web world, transforming totally the websites that have static pages. Another important PHP characteristic is that, besides being free, is an open source code software¹⁵. Also it is a server-side scripting language, which can be embedded in HyperText Markup Language (HTML) or used as standalone binary (although the former use is much more common)¹⁶.

Otherwise, the programming language JavaScript (JS) is part of the triad of technologies that all web

developers must know: HTML to specify the content, Cascading Style Sheets (CSS) to specify the presentation, and JS to specify the behavior of web pages. All three languages working together to make the implementation more interactive and responsive. Also, the overwhelming majority of modern websites use JavaScript, and all modern web browsers (on desktops, game consoles, tablets and smartphones) include JS interpreters, making it the most ubiquitous programming language in history¹⁷. These eases were fundamental to the VLE creation and application success, demonstrating, this way, the importance of seeking new non-formal learning methods.

Other interesting functionality to mention here is a responsive web design¹⁸, built with HTML and CSS allows a website to "just work" across multiple devices and screens. It enables the layout and capabilities of a website to respond to their environment (screen size, input type, and device / browser capabilities). The VLE supports this modern solution that has been used since 2012 over the internet¹⁷.

In this context, to improve the product quality, it's suggested the hiring of professionals from: informatics, data processing, publicity and advertising areas. These are recommended to layouts' adequacy, diagram creation and publishing. The knowledge about specific softwares will contribute to improve the final quality and give a professional aspect to the intellectual production⁸.

Thus, we observed that in the technological development scope, the good quality material, correct usage of tools and students' interest reveal the efficacy. It's believed that this initiative has the potential to bring even more satisfactory new results to Nursing undergraduates, also to contribute to the scientific community in development of new studies of comparison between the conventional and non-conventional methods of learning about Basic Life Support.

V. CONCLUSION

Making part of the construction of a Virtual Learning Environment, organizing, planning and proposing activities, opens up new possibilities of professional growth. Otherwise, it presents challenges to the development of thought and written abilities expressions, and to the insertion of new technologies at Nursing teaching, inciting new experiences search to such teaching modality.

In reference to teaching and researching, it arises from this study as a valid educational technology, based on the international consensus of Science of Resuscitation from AHA 2020, innovative and ready to be used. The

expectation, at this scope, is that the VLE – "Training in Basic Life Support (BLS)", awakes higher education managers, professors and students to a more rigorous look regarding the importance of BLS inclusion in the curricular components within Nursing Graduation Courses – in a more consistent way, caring about the current epidemiologic reality, in an innovative methodological perspective.

It's considered that, in the present educational context, there is a demand of opinion builder professionals. This way, needs of new practices of teaching-learning are emerged, by the use of didactic and technological resources, stimulating and favoring betterment and training of nurses, yet making possible the autonomous learning.

At this perspective, it's evidenced the necessity of comprehending and incorporating a virtual learning environment as an efficient educational device, and to get aware of this knowledge as a strategy to add up new experiences and values to professor's practice. The present paper is believed to be able to contribute with the innovation of nursing teaching, from the virtual educational proposal about a matter of great academic, scientific and social relevance.

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3D printing by additive manufacture of hydrogel containing caffeic acid

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Keywords—Additive manufacture, caffeic acid, hydrogel.

Abstract—In this work, 3D extrusion-based printing head was used to produce 3D geometry of hydrogel containing caffeic acid (CA). The hydrogel was prepared with 10wt.% polyvinylpyrrolidone (PVP) and 3wt.% sodium carboxymethylcellulose (CMC) using deionized water as solvent (PVP-CMC hydrogel), likewise the PVP-CMC hydrogel containing CA was prepared but was added 2wt.% CA (PVP-CA-CMC hydrogel). The rheological properties of the hydrogels were obtained using a modular rheometer with plate-plate geometry. The PVP-CMC hydrogel presented shear-thinning flow behavior and the adding of CA did not affect its rheological behavior. The power-law model described the shear-thinning curves of the hydrogels. Frequency sweep tests demonstrated that the PVP-CMC and PVP-CA-CMC hydrogels presented a physical gelation characteristic of the solid behaviors. The IR spectroscopy chemically characterized the hydrogel, indicating by carbonyl peaks a good intermolecular interaction between the functional groups. Therefore, we demonstrated the printing capacity of the PVP-CMC inks with caffeic acid, which makes it interesting to additive manufacture field.

I. INTRODUCTION

Three-dimensional printing is a new strategy in the design market first introduced in 1980 using the technique of stereolithography [1]. Its principle of operation consists of the creation of prototypes by means of layers, where a

material called ink is deposited with precision by predefined digital models [2-4]. Three-dimensional (3D) printing in the last ten years has had a constant evolution, an example of which is bioprinting, a technique in which it is linked to cell biology and materials science [5]. Compared with other manufacturing techniques where

molds are required, this technique allows obtaining structures in different sizes with greater precision and at less time and cost, making it economically favorable [6].

Carboxymethylcellulose (CMC) is a semi-synthetic copolymer composed of cellulose and monochloroacetic acid in sodium hydroxide in an alcoholic medium [7]. The presence of carboxylate groups along the chain promotes the solubility of CMC in water, which, together with the low cost and advantageous properties of polysaccharides (such as biodegradability, biocompatibility, and mucous adhesion), has been used in a variety of industrial applications, as in the food, cosmetic, pharmaceutical and oil industries [8]. Comparing the mechanical properties of polyelectrolytic complexes formed by the combination of CMC with other polymers, there was an improvement in the modulus of elasticity tensile strength [9], i.e., being interesting for investigation as blends with other polymers.

Polyvinylpyrrolidone (PVP) is a polymer soluble in water and organic solvents capable of forming stable complexes with other compounds [10,11]. PVP polymer has strong hygroscopicity and can retain more than 0.5 mol of water per mol of polymer; due to its structure consisting of polar amide groups and non-polar methylene and methyl groups. For this reason, the PVP is amphiphilic. These characteristics are related to the wide application of PVP and its copolymers in the pharmaceutical industry [11,12]. Studies have shown that the use of PVP in hydrogels decreased the size of the polymeric network and the average molar mass between cross-links, and the degree of swelling in dressings [13].

Mechanical properties of the PVP are inappropriate for determining applications, i.e., has a low swelling capacity [14]. On the other hand, blended with other polymers can acquire properties interest and meet the main requirements for 3D hydrogel printing, which is structure, stability, and properties [15]. In literature, any published articles demonstrate the possibility of combining the PVP with CMC for the blend formation [14,16-18].

Caffeic acid (CA) is a phenolic compound derived from hydroxycinnamic acid and is one of the most widely distributed phenols in plant species. In addition to current medications, those that contain propolis, this acid is also present in various foods, herbs, and beverages, such as coffee, wine, apples, green tea, edible fungi, etc. [19]. In addition to having antioxidant activities, caffeic acid also has anti-cancer and antimicrobial properties, and studies show that CA has the potential to be used as a photoprotective agent when applied to skin cosmetics [19,20].

Recently, researchers [21] used an emerging technology to incorporate CA into poly (caprolactone)

fibers by electrospinning. Due to the excellent antioxidant property of CA, the authors determined and suggested an ideal concentration of the incorporation of CA in PCL fibers without defective structures. The CA-loaded microfibrinous PCL mat is interesting for application in the pharmaceutical and cosmetic areas.

Amorim et al. [22] approached the bioprinting technology originated from 3D printing. Normally, cells and/or bioactive compounds are added into biomaterials aiming the hydrogels formulation for 3D printing.

This work aimed to prepare the hydrogel formulation containing CA, characterize it chemically by IR spectroscopy, perform rheological testing, and evaluate its capacity of 3D printing.

II. EXPERIMENTAL

1.1 Materials

The materials used in this research were polyvinylpyrrolidone (PVP, MW = 1300000 g.mol⁻¹, Sigma-Aldrich), sodium carboxymethylcellulose (CMC, MW = 250000 g.mol⁻¹, DS = 0.7, Sigma-Aldrich), and caffeic acid powder (CA, MW = 180.16 g.mol⁻¹, Sigma-Aldrich). Deionized water with electrical conductivity of 0.5 μ S/cm² was used.

1.2 Prepare of the hydrogels

All solutions were prepared using deionized water. PVP/CMC/CA solutions were prepared using 10wt.% by weight of PVP, 3wt.% by weight of CMC, and 2wt.% by weight of CA. Initially, the PVP/CA solution was prepared using a magnetic stirrer for 1 hr. CMC powder was added gradually into the solution PVP/CA over a period of 10–30 s to reduce the dispersion time, and a clear solution was obtained later of 12 hours of stirred at room temperature.

1.3 Rheological characterization

The rheological characterization was performed using an Anton Paar MCR-102 Modular Compact Rheometer using plate-plate geometry (PP50-1) with a 50 mm diameter and a gap of 1 mm to 25 °C. Measurements of the shear rate in the steady-state were performed in the range of 0.1–600 s⁻¹. Finally, frequency sweep tests were conducted in the range of 0.1–500 rad s⁻¹.

1.4 Chemical Characterization

Chemical characterization was performed by infrared spectroscopy using a spectrometer (Thermo Scientific, NICOLET iS5). All the samples were mixed with potassium bromide (KBr) in 1:100 and analyzed at 25 °C. The analysis was carried out with range from 400 to 4000 cm⁻¹, 2 cm⁻¹ resolution, and 32 scans.

1.5 3D extrusion-based printing

Regarding 3D printing, the 3D extrusion-based printing head was used with the optimal PVP-CA-CMC ink. The g-code files containing the printing paths were generated using the software BioScaffoldsPG [23]. All samples were centrifuged at 4000 rpm for 5 min (Kasvi, K14-4000 model) centrifuge before printing. Then, 3D geometry of four-layers of the material were deposited (using a dosing distance of 0.2 mm, 22G needle, printing speed of 15 mm s⁻¹ and a piston speed of 1.052 mm min⁻¹), and subsequently observed in a stereo microscope (Olympus, SZ-CTV model). The width of filament was measured in FIJI app. The Fig. 1 shows a schematic illustration of the preparation and the 3D printing of the 3D geometry of PVP-CA-CMC hydrogel.

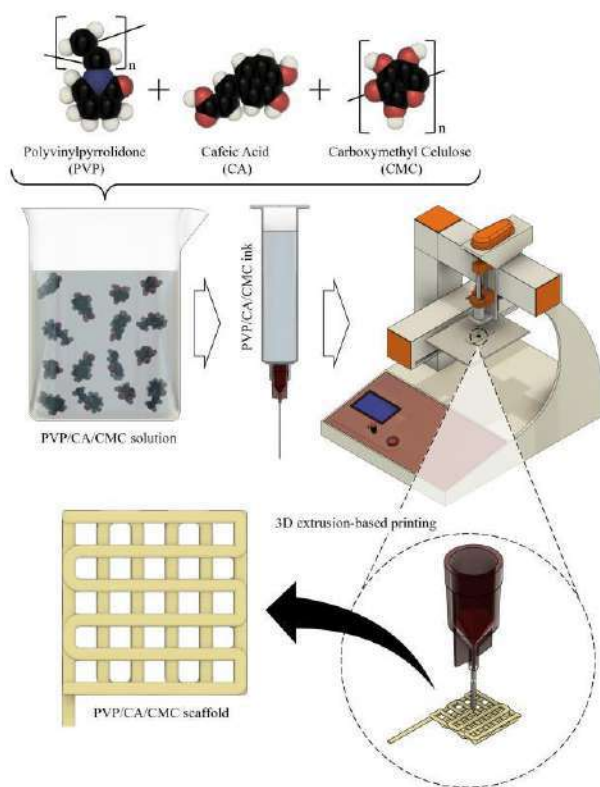


Fig. 1: Schematic illustration showing the prepare and the 3D printing of the 3D geometry of PVP-CA-CMC.

III. RESULTS AND DISCUSSION

This study shows the ability in 3D printing process of PVP-CMC hydrogel with CA from rheological and chemical characterizations. This printability was initially evaluated with steady-state viscosity and frequency rheological tests.

As seen in Fig. 2(a), viscosity decreases in solutions with and without CA as the shear rate increases. This behavior is known as shear thinning behavior and is

associated with the entangling properties of polymer solutions [24]. The shear-thinning behavior is a requirement in 3D printing processes where the material, when subjected to high shear rates must flow (reduction of viscosity) and vice versa. Finally, the viscosity and the pseudoplastic behavior were not affected by the addition of CA.

The shear-thinning curves (Fig. 1) mentioned above clearly shows that the viscosity depends on the shear rate. For this reason, we used the power law model to describe this behavior by equation (1):

$$\eta(\gamma) = K\gamma^{-n} \quad (1)$$

where $\eta(\gamma)$ is the viscosity, γ is the shear rate, K is the consistency index, and n is the flow behavior index. The fitted K and n values, including the R^2 , are listed in the Table 1. Although the shear-thinning curves are similar, we observed an increases in the K when the CA to be present in the hydrogel.

Table.1: Fitted K and n values using the “equation 1”, including the R^2 values.

Power-law model	PVP-CMC Hydrogel	PVP-CA-CMC hydrogel
K	278.1	307.6
n	0.271	0.233
R^2	0.9972	0.9961

Fig. 2(b) is shown the frequency sweep results used to analyze the viscoelastic behavior of the PVP-CMC and PVP-CA-CMC hydrogels. It is confirmed that PVP-CMC with or without CA hydrogels behaves mainly as a solid ($G' > G''$) throughout the studied frequency range. This could be associated with gel formation caused by the entanglement and disentanglement of the CMC polymer chains with the PVP chains. Additionally, it was observed that the addition of CA did not significantly influence the viscoelastic properties of the PVP-CMC hydrogel.

Next, print tests were performed with the PVP-CA-CMC hydrogel. As shown in Fig. 3(a) and 3(b), it was possible to extrude the material through the nozzle and generate a printed structure which begins to collapse as the number of layers increases, but for structures that do not require large sizes it can be had considered as a printable ink and possibly applicable in areas such as medicine or in bioprinting processes. In Fig. 3(a), the filament diameter (df) was measured, obtaining a diameter of 0.638 ± 0.040 mm. The diameter calculated was compared with the nozzle diameter (0.41mm). It was evidenced that the

filament expanded later of extrusion due to the viscosity of the solution.

Finally in the figure 3(b), the pore diameter (dp) was also calculated with mean pore values highlighted in green circle. It was possible to observe that in the filaments where the impression began, the pore size was 0.34 ± 0.326 , much smaller than the diameter presented in the center of the scaffolds. The dp of the center showed a value of 0.973 ± 0.05 and better precision and qualitative quality, being three times greater than the dp of the corners.

FTIR spectroscopy was performed to identify the functional groups that formed after the preparation of the PVP-CMC ink with and without caffeic acid and to investigate the preference for interaction of CA.

The FTIR spectra of genuine PVP and CMC polymers and the mixtures of PVP-CMC and PVP-CA-CMC hydrogels are shown in Fig. 4. For genuine CMC and PVP polymers and caffeic acid, the main vibrational bands were determined and followed by literature [25-28].

In Fig. 4, the PVP-CMC hydrogel spectrum exhibited the OH group at 3428 cm^{-1} and the carbonyl group ($\text{C}=\text{O}$) at 1660 cm^{-1} from the PVP; and the carboxylate group ($-\text{OOC}$) and ($\text{C}-\text{O}-\text{C}$) at 1600 cm^{-1} and 1068 cm^{-1} from the CMC, respectively. Therefore, the PVP-CMC hydrogel spectrum exhibited vibrational bands related to the functional groups of the PVP and CMC components that imply miscibility between the polymers [29,30]. The two polymers interact with each other by hydrogen bonds favoring a good hydrogel formulation.

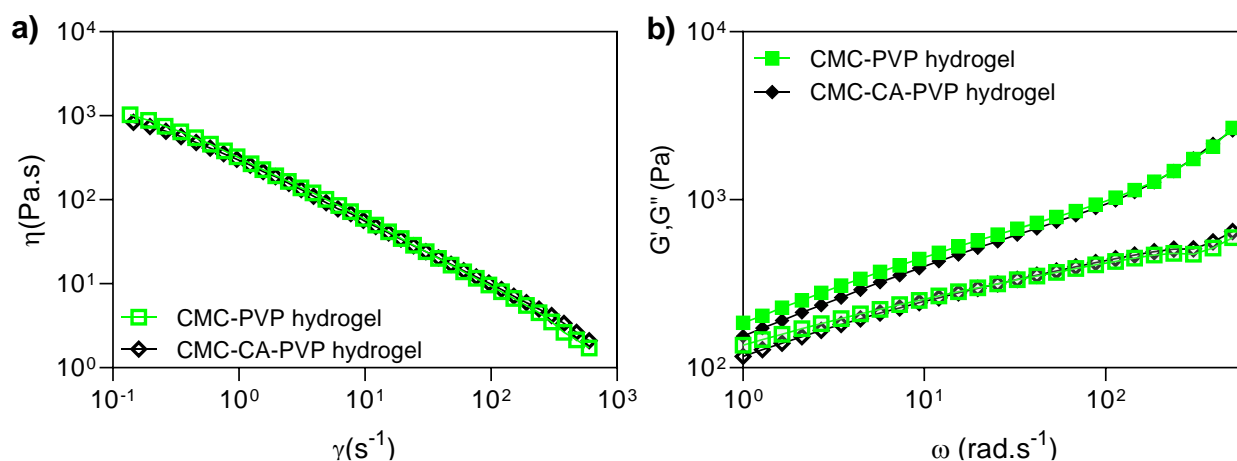


Fig. 2: Viscosity curves for CMC-PVP and CMC-CA-PVP hydrogels (a). Dependence of G' (solid symbols) and G'' (open symbols) on the angular frequency for CMC-PVP and CMC-CA-PVP hydrogels (b).

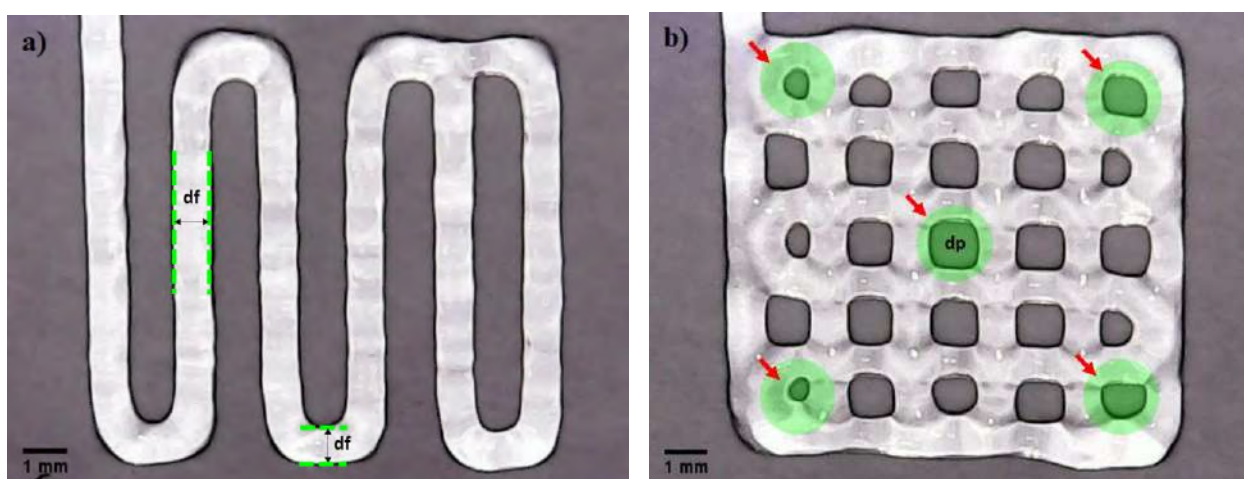


Fig. 3: Fabricated scaffold of CMC-CA-PVP for one-layer (a) and (b) four-layers, respectively, indicating the filament diameter (df) and pore diameter (dp) of the 3D geometry imprinted of CMC-CA-PVP.

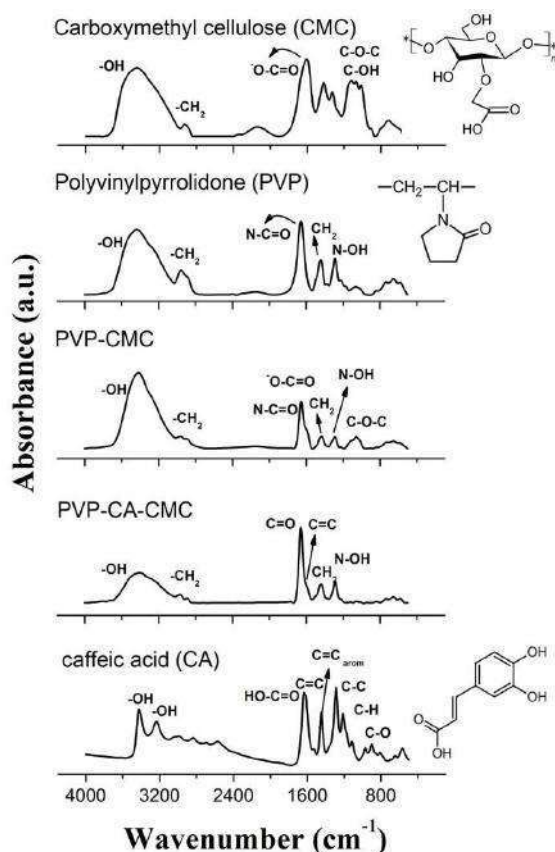


Fig. 4: FTIR spectra of CMC, PVP, PVP-CMC, PVP-CA-CMC and CA.

Analyzing the carbonyl region in detail, Fig. 5 presents the FTIR spectra in the region from 1800 to 1200 cm^{-1} and with the bands corresponding to the deconvoluted carbonyl group in two curves. The carbonyl peaks for the PVP-CMC and PVP-CA-CMC formulations showed greater absorbency intensity and lower full width at half maximum (FWHM) values than the CMC and PVP peaks, indicating a good intermolecular interaction between the functional groups.

The ratio of peaks I/II to PVP-CMC and PVP-CA-CMC are equal to 0.76 and 0.80, respectively, showing that the presence of CA contributes to greater freedom for the movements of the PVP carbonyl and greater restriction of movement vibrational pressure for CMC carboxylate. Still for the PVP-CA-CMC hydrogel, the absorbance of the group -OOC is greatly reduced after the addition of caffeic acid, while the intensity of the vibrational band of the group C=O increases significantly. This shows that caffeic acid prefers interacting with CMC carboxylate. Furthermore, the addition of caffeic acid (CA) in the formulation of the PVP-CMC hydrogel, did not interfere with the miscibility property between polymers.

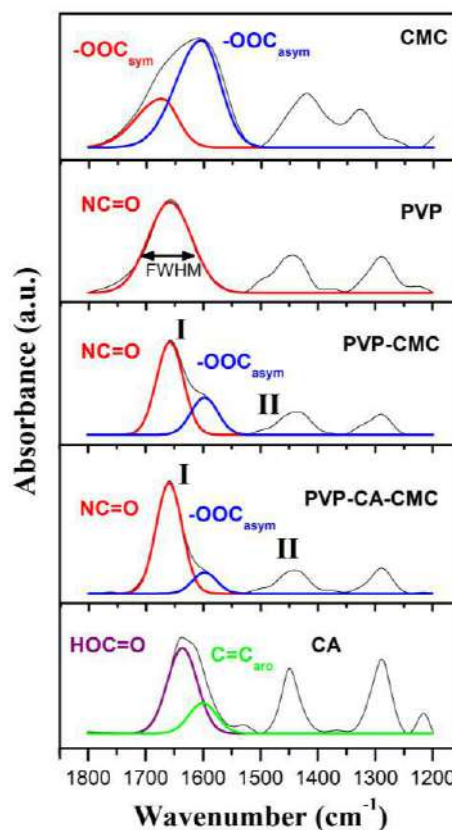


Fig. 5: Vibrational region of deconvoluted carbonyl in two Gaussian curves in the 1800 to 1200 cm^{-1} region.

IV. CONCLUSION

3D geometry of the porous structure of the PVP-CA-CMC ink was successfully manufactured by additive manufacturing. The rheological studies allowed the analysis of the rheological properties. The addition of CA did not influence the pseudoplastic behavior of the PVP-CMC hydrogel. Frequency sweep tests demonstrated that the hydrogels with and without CA presented a physical gelation characteristic of the solid behaviors. The carbonyl peaks for the PVP-CMC and PVP-CA-CMC formulations showed greater absorbency intensity and lower FWHM values than the CMC and PVP peaks, indicating intermolecular interaction the functional groups. The printing capacity of the PVP-CA-CMC ink was demonstrated, making it attractive to additive manufacturing for 3D printing hydrogel with CA.

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Evidence of GLBT in Brazilian Scientific Research: A State of the Art

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Keywords— *Qualitative Research. Sexual
Gender and Minorities, Systematic Review.*

Abstract— A systematic qualitative review of State of the Art type developed to know the scientific evidence which exhibits Brazilian Lesbian, Gay, Bisexual, Transvestite, and Transgender people experience. Texts included the LGBT population from 18 years of age. Inclusion criteria involved articles which investigated LGBT population experiences in diverse social institutions and time frame from 2009 to 2019. This research was conducted (February-April/2019) in four scientific databases aiming to identify texts in Portuguese. We followed the PICo protocol for elaborating the starting question, the PRISMA for eligibility, and Meta-Aggregation in Phenomenological perspective for analysis. We included fifteen articles and those found are presented in two categories of qualitative synthesis. Pathologization, stigma, and prejudice earmark LGBT relationships and institutions, reinforced by heteronormativity. However, there is a health guarantee from Transsexualizer Process. This review points out low evidence about the transgender experience in social environments and portrays that institutional violence stands out in disrespect for human rights.

I. INTRODUCTION

The sexuality approach has a hard and complex historic referral in Brazil, closely following, although, with great modesty, the unveiling of facts that happened in the Old World, in already developed first-world countries. Foucault (2014) asserts in the first volume of his work *The History of Sexuality I* that the theme was retracted to the alcoves with European bourgeoisie outbreak when speeches are used as power devices and marriage was unveiled as reproduction-intended, controlling, since then, bodies.

The logic that the biological binary man and woman, male and female is the pattern model and adequate puts any other kind of gender and/or sexual identity manifestation, as well as a sexual orientation as an affront to values and moral costumes which are rooted in the patriarchy, a system that has like central figure the father, male, family provider, as well as implementation of

heteronormativity as correct conduct (Pinto & Silva, 2019).

The State, as a maximum instance, which controls all and everyone, developed what Foucault called as biopower, a mechanism of body domination in any situation that happens outside the patriarchal pattern of a mononuclear and traditional family, establishing, making it a disorder of any other gender expression or sexual manifestation which are not opposed to oneself, as it happened with the madness phenomenon. Therefore, men who had/have sex with men, women who had/have sex with women, people who cross-dress or transit between genders due to their non-recognition with gender and birth biological sex and so many other situations are immediately pathologized. It means a disease to be treated, arising thus homosexuality, lesbianism, transsexualism, hermaphroditism among other terms with suffix *-ism*

which brings in its etymology the meaning of disease (Furtado & Camilo, 2016).

Such a process of sickening the healthy body needed to be legitimate by a science. Psychiatry technically defined that nomenclature would receive a pathology related to the sexuality of an individual, of the feeling of not belonging to one's physical and biological body, from Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition – DSM IV named as Gender and Sexual Identities Disorders changing to Gender Dysphoria in Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition – DSM V (American Psychiatric Association, 2014).

Whilst transsexualism appears as a psychiatric disease, susceptible to State control, institutions appear that claim the right to treat such pathology. In Psychology field, arguments arise from professionals as the gay cure, though the Psychology corporate board in its own legislation, Resolution N° 199 (Medicine Federal Board, 1997), forbids with vehemence the psychologist of acting in the supposed gay cure. This movement gains followers in the most conservative religious institutions and divides opinions that show an LGBT cure is possible from a whole of religious apparatus, repentance, and denial as if this way of living was wrong, condemned by religiosity.

Pinto and Silva (2019) states that the dispute between professionals that are followers or against how transsexuality is considered gained a new chapter when International Classification of Diseases - ICD depathologized transsexuality. This episode caused a certain dislike among conservative religious people who consider LGBT to be an affront to society and the family. Nevertheless, the understanding of autonomy in making the Transexualizer Process comes with Resolution No. 1482/1997, which established the conditions for a person to go through this process.

Transsexuality and the transexualizer process as emerging demand in all social environments and groups. As for the Brazilian Unified Health System (SUS), it requires professionals who are able, since starting qualification, to assist this minority group demands, marginalized. However, this access is denied as result of the feeling of not-belonging to offered services as of different ways of exclusion and disrespect.

We have an approximation to the context of this qualitative systematic review of the kind State of the Art in three situations: belonging and place of speech by one of us to LGBT population; Identification of LBGT population invisibility related to health in our early academic formation - Medicine (from 1980) and Nursing (2016). Such invisibility state occurs even after official documents depathologized gender identities. Another factor that brings

us close to this theme is our monitoring of offering the Transexualizer Process Service in a reference hospital in the capital city of Ceará state, Fortaleza city.

We carried out in advance researches to identify the existence of qualitative systematic reviews about the topic, what confirmed the necessity of developing this review because of knowledge gap there is that gathers scientific evidence that portrays LGBT experiences phenomenon in different social institutions, seeing those studies talk about it, but in individual character.

From the above, we highlight that this qualitative systematic review of State of the Art type has the general objective to know scientific evidence that unveils experience of Brazilian Lesbian, Gay, Bisexual, Transvestite and Transsexual people. This study is part of a larger study entitled 'Interface between subjectivity and the quality of life of transgender persons in the transexualizer processes.

II. METHODS

This is a qualitative systematic review of the kind State of the Art which intent is to present data about a specific theme in qualitative and/or quantitative ways. Such type of literature review seeks to reflect upon which space has been occupied by a specific agenda inside the literature, contributing in an exponential way in the perception of knowledge gaps.

This modality can also focus on a specific line of research, or on production of *Stricto Sensu* graduate programs of Brazil. Although it brings in its scope the mission of placing academic production around a given subject, State of the Art literature reviews finds limitations, as in any type of study, given its development dynamic.

The research named State of the Art summarizes what has been produced in the academy, or still published in journals. Ferreira (2002) clarifies three complexities in developing this type of study: the researcher will not be able to historicize a theme, but only present a fragment of it; acquisition difficulties because of the possibility of reading only the abstracts, since they can be fragile in presenting all the information that comprises the study; and recognition that one's abstract will be an interconnected network from the production of others.

Thus, it is possible to call State of the Art Literature Review as research that aims to group scientific publications published in national and even international journals and/or academic productions of graduate programs in Brazil, or in Academic-Scientific Annals and Minutes of National and/or International Events around a specific theme, understanding which paths and spaces it

occupies (Ferreira, 2002; Silva, Barbosa, Pedro, & Muniz, 2005).

The State of the Art study is one of the possible qualitative research developments that has a prominent place because it does not require quantitative data with exclusivity for its representativeness and validity. It seeks rather apprehend its study object and understand how subjective elements represent, mean and give meaning to experiences lived by the subjects (Sampieri, Collado, & Lucio, 2013).

With didactics, it is recognized that qualitative research has its genesis in the first half of the 20th century, between the 1920s and 1930s in Human Sciences Area, specifically within knowledge production in Sociology and Anthropology. Within Health Sciences field, qualitative research tends to measure how the subject and its dimensions, whether psycho-emotional, social, economic, religious, etc., suffer interference from different performances in dynamics with the phenomenon at its different depths (Augusto, Souza, Dellagnelo, & Cario, 2019; Oliveira, Baixinho, & Presado, 2019).

In proposing this Qualitative Systematic Review of State of the Art type, we follow *Joana Briggs Institute* protocol (Joana Briggs Institute [JBI], 2019) for Systematic Reviews that indicates seven steps to follow: (i) Formulation of review question; (ii) Defining inclusion and exclusion criteria; (iii) Location studies through searching; (iv) Selecting studies for inclusion; (v) Assessing the quality of studies; (vi) Extracting data; (vii) Analyzing and synthesizing the relevant studies; (viii) Presenting and interpreting the results potentially including a process to establish certainty in the body of evidence. We describe how these steps were conducted in this study. We clarify that two or more steps were performed in concomitance.

For formulating the starting question, we used the acronym PICo (Population, Interest/Phenomenon, Context) indicated for qualitative research, and so the question was developed as “What is the State of the Art of Brazilian research in databases Pubmed, Directory of Open Access Journal (DOAJ), Scientific Electronic Library Online (SciELO) and EBSCOHOST about the LGBT population and their experiences in different social institutions?”. The choice of the four databases mentioned above was made considering its degree of national and international coverage as well as the possibility of free access to complete texts.

We used as inclusion criteria, addressing LGBT people experience in social institutions, being published within the time frame from January 2009 to April 2019, complete texts, published in Portuguese, contain at least one of the

descriptors, defined for the research, in the title. As exclusion criteria, we adopted those duplicated texts in the databases, quantitative studies or those that did not make explicit the methodology adopted in the text development.

The indicated time frame is justified because it was in 2009 that the main public policy on LGBT health started to be formulated in Brazil, the National Policy for Comprehensive Health for Lesbian, Gay, Bisexual and Transvestite Population within SUS scope. The health descriptors used were determined based on two criteria: the authors' knowledge of the subject and the validity of descriptors in the Health Descriptors Database of the Virtual Health Library.

Root-descriptors in Portuguese and English were used, such as “transexual”, “família”, and “Sistema Único de Saúde” and their derivatives “transexualismo”, “pessoa transgênero”, “transexualidade”, “LGBT”, “família”, “Sistema Único de Saúde” “transsexualism”, “transgender person” “transsexuality”, “LGBT” “Family”, and “Unified Health System” associated to Boolean descriptor AND aiming to expand the study scope.

Crossings were made initially in pairs and in Portuguese: “transexualismo” AND “família”; “transexualismo” AND “Sistema Único de Saúde”; “pessoa trans” AND “família”; “pessoa trans” AND “Sistema Único de Saúde”; “transexualidade” AND “família”; “transexualidade” AND “Sistema Único de Saúde”; “LGBT” AND “família”; “LGBT” AND “Sistema Único de Saúde”; after in English “transsexualism” AND “family”; “transsexualism” AND “Unified Health System”; “pessoa trans” AND “family”; “pessoa trans” AND “Unified Health System”; “transexualidade” AND “family”; “transexualidade” AND “Unified Health System”; “LGBT” AND “family”; “LGBT” AND “Unified Health System”.

The question being formulated, inclusion and exclusion criteria being defined, descriptors defined and applied to databases, it was time to use the PRISMA protocol (Mother, Liberaty, Tetzlaff, Altman & The PRISMA Group, 2009) which is not authored but approved by the JBI. This protocol adopts four phases: (i) identification, which defines databases to be researched, (ii) screening - partial result after main selection criteria application, (iii) eligibility that will promote filters based on other criteria and (iv) inclusion, the quantity of texts selected for qualitative synthesis. The use of the PRISMA flow-diagram and its results are shown in Figure 1.

For this Qualitative Systematic Review of State of the Art type, we used as eligibility criteria, those that were not duplicated in the databases, that were not of a quantitative or mixed approach, did not have the Methodology section,

had no specific methodology whether qualitative, quantitative or mixed and were not complete as shown in Figure 1.

After carrying out the previous steps, the text followed the Meta-Synthesis protocol in the Phenomenological perspective when studies are evaluated, data are extracted, analyzed and grouped into qualitative synthesis categories, after which data are presented.

In order to evaluate and extract the data, not only the abstract was read in order to avoid any kind of bias in the research. Ferreira (2002) also points out that just reading the abstract can be a problem for State of the Art literature reviews since each journal has its own forms of textual structure and there may be loss of information or partial information that ends up being cataloged.

For treatment and analysis of the data, we opted for using the theoretical-methodological concepts of the Merleau-Ponty Phenomenology, in a way adapted to a study of State of the Art, which presents five phases for organization and treatment of data according to the following summary table: first is the phenomenological suspension, a stage in which the reader reads the material without any pretensions, it is a detached reading of the material; the second phase is going to the field, collecting and transcribing data; the third phase is, again, phenomenological suspension of knowledge about the subject; the fourth phase is the general syntheses of studied materials and identification of themes; and in the fifth phase is theoretical positioning on the phenomenon and the suspensions made (Pinto & Silva, 2019; Branco, 2014).

For data analysis, the instrument already developed by Ursi (2006, p. 126) was used, with necessary adaptations

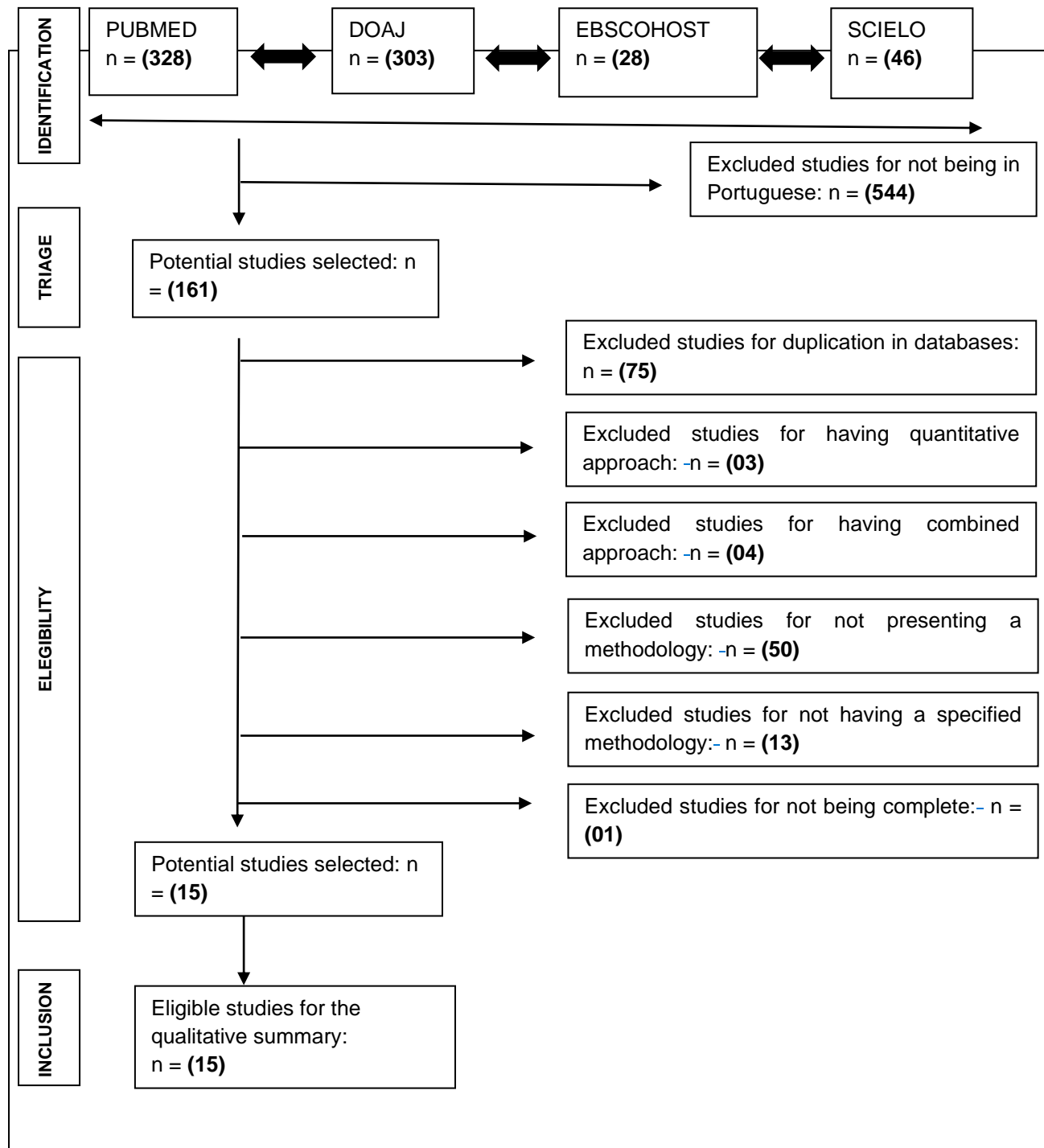
for this study, which analyzed “[...] name of the research; authors' names; studied intervention; results; recommendations/conclusions.”, adaptations of this study being the addition of information objective, type of study and participants.

From data collected and analyzed, synthesis is presented in two categories: Profile synthesis of articles included in the State of the Art study and Objectives, results, and final considerations synthesis of articles included in State of the Art study.

III. RESULTS

After following what the *Joana Briggs Institute (JBI)* recommends for identifying the guiding question of a Literature Review study, the processes for identification, screening, eligibility, and inclusion of the research texts were followed. In identification phase, using descriptors in Portuguese and English, we listed 705 potential manuscripts, reduced to 161 in screening phase when we removed texts that were in other languages, 15 texts were included for analysis after applying the eligibility criteria. Board 1 shows the scheme and phases followed in text identification.

Among the 705 collected manuscripts in the beginning in databases Pubmed, DOAJ, EBSCOHOST, and SciELO, fifteen texts were analyzed considering the instrument already validated by Ursi (2006) for manuscript analysis in Literature Review whose evaluative elements are: title, objective(s), presented results, and final considerations, as it appears in the following Board 2:



Board 1. Selection phases summary of texts selection for Literature Review

Fonte: Retrieved from Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement.” of Mother, D., Liberati, A., Tetzlaff, J., Altman, D. G., & The PRISMA Group, 2009, *PLoS Med* 6(7): e1000097. Retrieved from <https://doi.org/10.1371/journal.pmed.1000097>

1 - Gays, Lesbians, Bisexuals, Transgenders perception of the Brazilian Public Health Care System (SUS)	Cerqueira-Santos, E., Calvetti, P. U., Rocha, K. B., Moura, A., Barbosa, L. H., & Hermel, J.	Identify homophobia against gays, lesbians, bisexuals and transgenders who use the Brazilian public health system for prevention and treatment of STD/HIV/AIDS	Access to the public health care system; Evaluation of the system; Equality and specialization for the LGBT public; Reception, humanization and integrality; Discrimination and prejudice against LGBT group; and Suggestions to improve the system.	Heteronormative speech; Lesbian suffer in double by heteronormative speech; Transgender, transsexual and transvestite report system incompatibility with their practice and activities; Discrimination manifestation; Medical Alterity Pathological view of transsexuality and transvestite; There is no inclusion; Acknowledgement that there are negative results.
2 - Transsexuality : psychological characteristics and new demands on the healthcare sector	Sampaio, L. L. P., & Coelho, M. T. Á. D.	Investigate the situations experienced by transgenders in their search for harmony with their bodies, including before and after surgery.	Social and Family relationships; Before and after surgery period; Feelings and the hurting caused by gender identity inconsistency with biological sex; Confrontation strategies utilized in discomfort situations related to family, school, and society; Some reasons that lead transgenders to decide for surgery of transgenitalization, as well as mastectomy, hysterectomy and other surgeries.	Transgenders claim a physical transformation; Analysis of each individual history is indispensable; There is other hurting besides the psychic and the discomfort generated by the inconsistency between biological and psychological sex; It is claimed the qualification for Psychology professionals; Final decision about the surgery must be by the transgender person.
3 - Psychosocial aspects of homophobia in families and health of young lesbian and gay	Perucchi, J., Brandão, B. C., & Vieira, H. I. dos S.	Analyze as are the situations of homophobia in the context of family relationships experienced by lesbian and gay youth, examining the psychosocial aspects of them processes of rupture or temporary or permanent familiar bond.	Place occupied by truth games, power relations; Ways of relationship with oneself and with others; Construction of an experience field of sexualities of gay and lesbian youngsters.	Heteronormativity legitimates production and maintenance of many violence situations in the family; Research gaps about psychosocial aspects that involve, specially, gay and lesbian youngsters' experiences in violence and abandonment situation; Absence of adequate policies.

4 - Teachers' social representation s on sexual diversity in a school paraense	Neves, A. L. M., Sadala, K. Y., Silva, I. R., Teixeira, E., Ferreira, D. S., & Silva, F. A.	Identify and analyze the social representation of teachers on sexual diversity by the Central Nucleus Theory.	Used as theme fomentor "Sexual Diversity": Core elements (freedom and respect); Intermediary elements ("Homosexuality", "Sexual Orientation", and "Prejudice"); Contrasting elements (Acceptance, Human Rights, Family, and Equality); Peripheral elements (Bisexual, Other, Straight, Types of Acts Sexual, and Transexual).	Indicates the need for public policies which prioritize sexual orientation education, that clarify human sexuality faces and its ways of manifestation; Need for promotion of debates about inclusion process of projects related to sexual diversity; Picture understanding by teachers that diversity is a choice; Humanization of education; Necessity of a psychologist in the school.
5 - Violence and social distress among transgender persons in Santa Maria, Rio Grande do Sul State, Brazil	Souza, M. H. T., Malvasi, P., Signorelli, M. C., & Pereira, P. P. G.	Discuss the violence experienced by transvestites in the Family, school, police precincts, and health services.	Violence and social suffering in family; Violence and suffering in school; Violence and social suffering in health services;	Violence interferes in their life quality, pulls them away from their family and other social institutions; There is mental sickening as depression, suicide attempts, injuries and aggravations;
6 - Discrimination of transvestites and transsexual women in the labor market	Licciardi, N., Waitmann, G., & Oliveira, H. M.	Expose the current employability of transvestites and transsexuals in Brazil; Propose a new perspective for organizations to have inclusive and diverse environments, to fight prejudice and discrimination that this group faces.	Experience of aggression of any nature with family members; Support on transition process; Limitations in education access; Limitations in labor market access; Prejudice as reason for exclusion; Suggestion that The government should offer support so that their situation improves in academic and work environments.	It is necessary to make corrective actions in Family environment still in infancy and adolescence; It is necessary to implement practical policies of human resources so that work environment becomes more open and inclusive for these professionals; It is necessary to structure the work environment; It is necessary to train employees; Implementation of diversity management policies.
7 - Sexual diversity and homophobia: knowledge of nurses from	Silva, G. W. S., Sena, R. C. F., Cassiano, A. N., Sobreira, M. V. S., & Miranda, F.	Analyze the knowledge of nurses from the Family Health Strategy in relation	Approximation to an artistic manifestation: two songs - "Comum de dois" (approaches sexual diversity and refutes the search for	Participants show little of no knowledge about sexual diversity; It is essential to discuss about it in courses of the area and in

the family health strategy	A. N.	to sexual diversity and homophobia.	heteronormativity) and “Preconceito” (points out to the possibility of resisting to homophobic prejudice).	health services, being in management, assistance or research areas, valuing SUS to be popular, accessible and humanized.
8 - Youth, homosexuality and diversity: a study on the process of ‘coming out of the closet’ using body-maps	Murasaki, A. K., & Galheigo, S. M.	Study the perceptions and representation of young people on the process of <i>coming out of the closet</i> and the impacts on their daily lives regarding autonomy, inclusion and social participation.	Prejudice, Stigma and Empowerment; Discrimination, Isolation and Social Participation; Opportunities to change and Life Projects development.	There are divergences of speech among participants about prejudice and discrimination; It emphasizes the importance of an agenda of sexual and gender diversity in Education, Health, Social Assistance; Culture, and Work; Fight against heterosexuality naturalization; Fight against prejudice and discrimination.
9 - Difficulties experienced by trans people in accessing the Unified Health System	Rocon, P. C., Rodrigues, A., Zamboni, J., & Pedrini, M. D.	Discuss the difficulties of trans people living in the metropolitan region of Greater Vitória, Espírito Santo State, Brazil, in accessing the health services of the Unified Health System.	Access to health services; Methods used in body changes; Perception about the influence of such factors in their health [Social name and discrimination as health access dilemmas; The transexualizer process as a possibility for trans health promotion; Health requires a universal, integral, and equal SUS.	It is necessary to modify the diagnose in their function; Elaborate educational programs and permanent campaigns about the right of access to the health system free of discrimination and using their social names.
10 - Basic Health Units in Teresina-PI and the access to the LGBT population: what does doctors think?	Pereira, E. O.; Ferreira, B. O.; Amaral, G. S.; Cardoso, C. V.; Lorenzo, C. F. G.	Investigate the perception of physician in Basic Health Units of Teresina, which is considered one of the most homophobic Brazilian capitals, regarding the access and quality of care to the LGBT population.	Confused perception between universality and equity; Pathologization and perception of abnormalities in the condition; Denial barrier, denial of access, and accountability of the lack of demand for the service to the subjects themselves; Low demand from the LGBT population or invisibility of their condition.	Main challenge of implementing LGBT National Policy continues to be stigmas and prejudice incorporated in professional subjectivity.
11 - Social Trajectories of	Campos, D. A., & Moretti-Pires, R.	Analyze the effects of gender relations	Economic, cultural, and structural matters indicate	Family violence experienced or the possibility of it has emphasis

Homeless Gays and Lesbians in Florianopolis (SC)	O.	on the social trajectories of homeless people who identify themselves as lesbian and gay in the city of Florianopolis/SC.	exclusion; Inequality and violence of gender; Speeches about machismo and subservience of woman to man; Pathologization of conditions and behaviors.	in trajectories; There is double violence: to be LGBT and be homeless; The street is an adequate place to continue to live as a result of family conflicts; Need of actions aimed at LGBT youngsters who are vulnerable to avoid exclusion and then live on the streets; Expand studies with homeless LGBT youngsters.
12 - SUS out of the closet: conceptions of municipal health managers on the LGBT population.	Gomes, S. M., Sousa, L. M. P., Vasconcelos, T. M., & Nagashima, A. M. S.	Investigate the dimensions of health care for the LGBT population concerning SUS services in the city of Cuité-PB.	“Gossip, confusion and shouting”: differences, disagreements, and lack of knowledge about the LGBT population [Managers’ view of the LGBT community and also their demands]; Pathways and deviations towards a comprehensive LGBT health: weaknesses, potentialities, and process perspectives [LGBT Health: Whose responsibility it is? and Identified strategies	Participants has difficulties in acknowledging LGBT Community demands; The Health Network finds itself disjointed and without communication about LGBT population demands which abound attention levels; There are federal frailties to capillarization of federal strategies for local contexts; Investigate the barriers involved in LGBT popular participation and Their organizing dynamic. Expand discussions and cares towards LGBT population in educational institutions.
13 - What trans people expect of the Brazilian National Health System	Rocon, P. C., Sodré, F., Zamboni, J., Rodrigues, A., & Roseiro, M. C. F. B.	Discuss the criticism and suggestions made by transgender people to guarantee their access to the public health services, and regarding the health promotion through comprehensive care actions in the Brazilian National Health System (SUS).	Two axes: What do trans people expect for their bodily changes? What trans people expect about access to health.	The search for genitalia change is not unanimous among trans people of the research; Men point out to the difficulties of neophalopasty; Need for continuous training guided by humanization, dignity, respect for social name, gender identify; Critics to the biomedical model.
14 - Stigma and resistance	Magno, L., Dourado, I., &	Analyze experiences with	“That’s women stuff”: “effeminate” performances	Stigmatization process is operated by the power exerted

among travestis and transsexual women in Salvador, Bahia State, Brazil	Silva, L. A. V.	stigmatization by describing events, actors, and contexts that have marked their life stories, as well as elucidating the relationship between stigma and their female performances.	stigmatization; "I'm moving to Salvador city": life trajectories and social interactions; "Her death was not in vain": narratives of violence and resistance.	by compulsory heterosexuality laws over bodies and social relations of transvestite and transsexual women; Need for new investigations that can discuss and problematize some of the tensions and identity displacement, resistance movements to stigmatization process.
15 - Gender diversity and access to the Unified Health System	Ferreira, B. O., Pedrosa, J. I. S., & Nascimento, E. F.	Understand the dimensions of access to and comprehensive care in the Unified Health System (SUS) from the gender diversity perspective.	Gynecological care for lesbians; The effeminate gay in the health services; In search of equity for transvestites; The assumed name for transsexual women in SUS.	There is urgent need for access to comprehensive health care networks by the LGBT; need for knowledge about assistance specificities to each group of LGBT community.

Board 2: Analyzed manuscripts summary from databases DOAJ, PubMed, EBSCOHOST, and SciELO (2019)

Source: elaborated by authors from the databases (2008 -2019)

IV. DISCUSSION

Profile Synthesis of articles included in the State-of-the-Art study

From selected manuscripts, it is possible to trace State of Art of Brazil research scope aimed at the population of Lesbians, Gays, Bisexuals, Transvestites, Transsexuals, Intersex and Queer (LGBTTIQ +) in addition to criteria indicated in Table 1.

This study's starting point, the year 2009, is relevant because it was in November of that year the National Health Council of Brazil approved the National Policy for Integral Health of Lesbians, Gays, Bisexuals, Transvestites, and Transsexuals. In 2013 the booklet that gives health services guidelines to care for the LGBT population was launched (Brazil, 2011). We believe the impacts of that approval occur in the years 2015 and 2016 when we have the highest levels of academic production focused on transsexuality and LGBT issues in Brazil.

Since then Brazil has consolidated itself as the country that most commits homicide against the LGBT population. In the 10 first months of 2015, 313 (three hundred and thirteen) homicides of gays, lesbians, bisexuals, transsexuals, and transvestites were registered (Pinto, Rocha, Costa, Aguiar e Silva & Vasconcelos, 2016).

Data were identified on the database of the website maintained by the Gay Group of Bahia (GGB). This

ranking in 2016 maintained itself with 343 (three hundred and forty-three), 2017 with 445 (four hundred and forty-five) until 2018 with 420 (four hundred and twenty).

The number of texts can be presented as the first reflection of the LGBT Health Policy, especially because in the year 2018, out of the 05 published texts we have 04 focused on the health area, in 2015 we have 01 in the education area, 01 in the administration area, and one in the health area, in 2016 03 texts are focused on health area.

The same reality was not identified by Pinto, Ferreira-Junior & Silva (2018) when carrying out a similar study in databases of Master's Dissertations and Doctoral Theses of the Graduate Programs in Brazil. The area that stood out was Human Sciences with courses in Law and Psychology while in this study the greatest contribution was in the health area, 10 out of the 15 texts. It is important to state that descriptors used in this research are universal, not just focused on health.

Regarding journals' origin that published the manuscripts, greatest contributions are from those linked to higher education public institutions, as we have 10 journals from public universities with greater concentration in São Paulo state (04) and Rio de Janeiro state (04), both located in the Southeast Region of Brazil, Brasília state(01), located in the Midwest Region, in the South Region we have Santa Catarina state (01), 03 from private institutions located in Ceará state (01), Minas

Gerais state (01) and São Paulo state (01) and 02 from the Professional Association, 01 from Ibero-American Psychology with headquarters in the United States of America and 01 from Occupational Therapy. The states with the highest production are also those with the highest homicide rates (Michels & Mott, 2018).

Among publication availability, the number of texts made available by DOAJ database with the largest number of studies in Portuguese language called our attention, while other databases had a technical tie with 03 texts each. Despite calling our attention, we have not identified any weighting factors that should be highlighted.

In studies types field developed in the qualitative approach, exploratory research was highlighted with 07 studies, followed by Ethnography while the data collection technique that stood out was the interview with 11 texts that used it to seize the data, followed by participant observation (03) with a technical tie, focal groups (01) and triangulation (01), highlighting non-triangulation of techniques for data collection, in total 08 while triangulation was present in 07 texts.

It is important to highlight that interviews, as a data collection technique, has the advantage of collecting all participant's nuances, understanding that it is not only words that speak, but the body, the gestures, and movements as well. In this perspective, semi-structured interview used in phenomenological research does not stand out. Marconi and Lakatos (2010) and Gil (2016) claim that this type of interview has advantages in allowing the interviewer to conduct data collection based on events and processes.

Objectives, results and final considerations synthesis of articles included in the State-of-the-Art study

Texts selected to be part of this study have 7 different verbs in objectives: 'identify', 'investigate', 'analyze', 'study', 'explore', 'collect' and 'discuss', belonging to Analysis and Understanding categories of Bloom's taxonomy whose definitions are respectively "Ability to understand and give meaning to content." and "Ability to subdivide the content into smaller parts for the purpose of understanding the final structure." (Ferraz & Belhot, 2010, p. 426).

Verbs used by the authors reiterate the experience valorization, the point and meaning of the experience for the person, of what the phenomenon represents and how it interferes, positively or negatively in subject's relationships, linked with what Phenomenology as science and theoretical assumption, especially Phenomenology of Perception Merleau-Pontyana mentions about the subject, the lived experience, and the world.

Merleau-Ponty adds that man is a component part of a whole and that being part of this whole reduces the experience lived by the subject, starting from their body and their self in relations with others, thus distancing Cartesianism, recognizing the existence of the world even before its reflection, is more than an object, it is the fruit of its experiences (Merleau-Ponty, 2011; Pinto, 2016).

Considering the data collection technique, listening to the other stands out through semi-structured interviews, focus group and triangulation group, narratives, life history among others that facilitate, including phenomenon exposure by the participant. For data analysis, researchers opted for Minayo Thematic Analysis (01), Bardin's Content Analysis (05), Orlandi's Discourse Analysis (01) as well as Foucault's Discourse Analysis (01), Hermeneutics- Dialectic (02) with the use of EVOC software (01), Narrative Theoretical Analysis (01) and those who do not mention the data analysis procedure (03).

The theoretical-methodological techniques described above resulted, after analyzing data, in 07 studies with category pointing, 02 studies pointing out axes, 01 with evocative houses, 03 studies without categories, and 02 that do not mention an organization and data presentation, promoting a reflection that permeates different themes.

Regardless of how data were organized in Results and Discussion, it is important to highlight that there are themes that deserve to be highlighted due to their presence in the studies analyzed here. The processes involving the Unified Health System and its doctrinal principles such as equity, comprehensiveness, and universality, but not only these, such as prejudice, discrimination, and invisibility, are pointed out in studies by Cerqueira-Santos, Cavelti, Rocha, Moura, and Hermel (2010).

The same conditions mentioned before are noticed at other institutions, not only health institutions but also schools, as pointed out by Neves, Sadala, Silva, Teixeira, Ferreira, and Silva (2015) and Magno, Dourado, and Silva (2018), and also at police stations as pointed out by Souza, Malvasi, Signorelli, and Pereira (2015), and still in the labor market environment according to the study by Licciardi, Waitmann, and Oliveira (2015), and Murasaki and Galheigo (2016).

Social relations noting difficulties in family institution are part of studies participants' reports by Perucchi, Brandão and Vieira (2014) in a severe way when there is dynamics of 'coming out of the closet', a recognized complex moment in the act of discovering oneself a member of LGBT community. This coming out of closet implies, in fact, the complexity of dealing with lesbotranshomophobia, with physical, moral,

psychological, emotional violence and its impacts on each person's life.

Problems of experiencing sexuality, body and gender transience are a challenge for all those who are part of the LGBTTIQ+ population. Hatred towards gays, lesbians, bisexuals, transvestites, transsexuals, intersex, and queers occurs in different ways and bodies fall to the ground due to different ways of practicing violence. In countless and overwhelming situations, the family, the first social institution to which the subject is inserted and maintains first contacts, are the genesis of exclusion, prejudice, discrimination and the notorious exclusion that LGBT people experience. They are speeches of power that seek maintenance of bodies in their places of origin, based on the principle of binarism that defines as being biologically correct only man (male) or woman (female), able to procreate (Perucchi, Brandão, & Vieira, 2014).

The State, in turn, sought to use pathologization discourse as a way of maintaining biopower over bodies. It determines that those who feel outside of their psychological body or even maintain sexual desire for the same sex, should be standardized and categorized as a disease, pathologizing thus homosexuality, transvestite, lesbianism, transsexuality (Pinto & Silva, 2019).

In addition, it stigmatizes (Goffman, 2017) that who, regardless of being a natural force, is something out of the pattern, as in the case of intersexuality. Defining, determining, marking that every male homosexual brings with him the femininity, so they are called with depreciation as effeminate (Ferreira, Pedrosa, & Nascimento) and female homosexuals, the masculinity, man's attitude which contributes to exclusion.

Depathologizing, then, sounds like a form of freedom for bodies and again, in Brazil, the ghost of gay cure appears (Campos & Moretti-Pires, 2018), a heteronormative discourse reinforced by doctrinal principles of religion, even though the World Health Organization (WHO) removed from the International Disease Code - 11 (ICD-11) the pathologization of transsexuality and in ICD-10 depathologized homosexuality (Health World Organization, 2018).

Merleau-Ponty (2011) in his work *Phenomenology of Perception* makes an important connection between body and life experiences, dimensioning how living experience, touching, and feeling are related to the way subjects see themselves in the world. In transsexuality, it seems to us that there is a rupture in this relationship between psychological subject and corporal subject since the transsexual person does not identify a relationship between the physical body and his 'soul', they mention a mismatch

and discomfort in the condition of living in a body that is not theirs.

This real conflict presents itself to the subject as a life dilemma that can today be minimized and even resolved with the Transsexuality Process, a legal procedure, regulated by Ordinances 1707/08 and 457/2008 (Brazil, 2008), the first being revoked by Decree 2803/2013 (Brazil, 2013), which regulates service provision in public hospital institutions based on assistance provided by a multidisciplinary team, as recommended by the Ministry of Health of Brazil. The process competes in two possibilities, first being the process with hormones, when there is pharmacological intervention with the purpose of blocking regular physiological pathways, for example, menstruation in addition to male or female characterization. Second possibility is sex reassignment surgery when trans men and women do sexual reassignment.

Sampaio and Coelho (2012), Rocon, Rodrigues, Zamboni and Pedrini (2016), and Rocon, Sodré, Zamboni, Rodrigues, and Roseiro (2018) state in their study that, for trans people, sexual reassignment surgery is the possibility of recognizing oneself in the physical body in which one finds oneself. It means to get out of the discomfort of dealing with a penis or a vagina when these seem to them physical anomalies to the encounter between the sexual organ and their self.

On the other hand, it legitimizes the discourse that, in order to be accepted, they must follow a social standard and that includes modifying the body, however, it is important to remember and place greater emphasis on understanding that sexual reassignment surgery has a direct impact on life quality and in the mental health of trans people.

Itinerary of transgender people in Brazilian Unified Health System (SUS) to perform sexual reassignment surgery is another problem pointed out by the participants of analyzed texts since diagnosis and authorization for surgical intervention come from reports issued by a multidisciplinary team after monitoring.

This itinerary also goes through different situations of prejudice and discrimination to which trans people are subjected in their care process within health services. Those are symbolized with the disrespect to social name and with the invisibility that professionals attest to this population as pointed out in the text of Pereira, Ferreira, Amaral, Cardoso, and Lorenzo (2017). The fact that doctors adopt a principle of criminal responsibility to justify the absence of the LGBT population stands out in

health units in Piauí state, endorsing still that there is low demand from the group in health services.

Participants of the 15 articles that we analyzed in this Literature Review point out the disrespectful way they are treated as one of the reasons for not attending health units, not recognizing this space as their own, but that reinforces the binary relationship. Gomes, Sousa, Vasconcelos, and Nagashima (2018) compare the medical perception in Piauí state with what managers from the semi-arid region of Paraíba state let show that they do not recognize demands from the LGBT community.

This situation is no different from what the study by Silva, Sena, Cassiano, Sobreira, and Miranda (2018) pointed out about nurses' knowledge of sexual diversity when it is evident that there is confusion in understanding the terms diversity and sexual orientation.

Texts that were part of this Literature Review point out the difficulties of life and survival in Brazilian society when you are LGBT, becoming even more complex as other issues are sectioned as education of both LGBT person and family, socioeconomic conditions, housing and cultural capital to face situations of exclusion. Still, there are criticisms about how health professionals serve LGBT people and the suggestion of offering permanent education in service for a more humanized, fair, equal, and universal service and policies demands that value LGBT labor thus avoiding the world of prostitution, a common path for many transvestites (Kullick, 2011).

V. CONCLUSION

This research sought to identify which spaces the transsexuality theme occupies in Brazilian scientific production over the 10-year time horizon (2009-2010) in renowned databases (DOAJ, PubMed, EBSCOHOST, and SciELO) using keywords in Portuguese and English, using as auxiliary the Boolean term AND to expand study scope.

We consider that scientific evidence related to transsexuality are still fragile, considering that it is a decade, when numerous historical facts happened such as the approval, by the Brazilian Ministry of Health, of the National Comprehensive Health Policy of Lesbians, Gays, Bisexuals, Transvestites, and Transgenders, as a proposal to offer to LGBT population health care that contemplates doctrinal principles of the Brazilian Unified Health System, namely, comprehensiveness, universality, and equity.

This same frailty leads us to understand that there are other institutional segments and social environments which stigmatize and turn LGBT people into potential victims,

promoting this exclusion, moral, social, and especially physical violence with death towards those who do not satisfy heteronormative patterns. Among these environments are the schools, a state ideological device which, according to the Brazilian Federal Constitution, must offer qualified education for everyone.

As researchers, we consider pertinent and necessary to invest in researches which elicit to reality the transsexuality phenomenon and LGBTTIQ+ life not only in numbers, quantitative research, but particularly researches that can understand what means to be LGBT in the country that most promotes homicides against this population, qualitative research, understanding that this research approach is able to reveal the reality lived from the place of speech of each person.

Qualitative research without doubts has an important role in complexities expression and is especially able to fire triggers of subjectivity, of empathy and resilience principles to keep oneself resistant and combatant against different ways of prejudice, violence, and disrespect to the right of living for everyone according to the Brazilian Magna Carta.

We suggest the development of a collaborative network of researchers with support from international institutions given that with Brazilian government's political reality of not favoring the right of each person to recognize oneself according to gender identity, sexual identity, and sexual orientation, is difficult to start, keep, and finish researches focused on this theme.

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Simplified Business Plan for planning and management - A proposal for the mariculture industry

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business planning, Alignment, Risk
management, Organization performance.

Abstract— Currently, the planning management of any company linked to the agricultural environment is directly related to the formation and development of market relations. Within this perspective, this work proposed the use of a simplified business plan with the reality of a small producer in aquaculture - production of aquatic organisms. Thus, after the implementation of the proposal, the benefits achieved were: the empirical demonstration of the theory of business plans; providing support for planning reproduction by other producers in this expanding market; and strategic gains for the entrepreneur, who now has a tool that enabled him to design medium and long-term scenarios. It is worth mentioning that this proposal, despite being based on the literature, allows the entrepreneur to review and parameterize it from new horizons. The results of this work can, therefore, help researchers, professionals and entrepreneurs to improve their practices and prescriptions, in addition to providing suggestions for new paths for the development of entrepreneurial methods.

I. INTRODUCTION

In the present competitive context, the absence of business planning is related to the expressive failure rate among small companies (Mazzarol & Rebound, 2020). This fact can be attributed to the tendency of restrictions in the informational and financial resources of these institutions, raising the urgency of aligning the allocation of resources to the strategic intent of their businesses (Grimmer et al., 2016). Reinforcing this understanding, Grimmer et al. (2018) reflect that the choice of a competitive strategy is one of the crucial business decisions, in order to optimize the distribution and integration of resources.

In this sense, according to Mazzarol (2001) and Mason and Stark (2004), the construction of an effective business

plan consists of a support tool for decision making, in addition to helping corporate dialogue with external stakeholders, such as accountants, bankers and Providers.

However, small companies tend to exhibit lower levels of systematic data collection and statistical analysis, compared to larger companies (Mazzarol & Rebound, 2020). Supply chain power problems and relatively higher operating costs are also recurrent. Nevertheless, many of them are notoriously successful and are in outstanding positions to respond, through innovation, to new market opportunities.

The aquaculture market was chosen for its notorious and emerging importance. Defined as “the creation of fish, crustaceans and aquatic plants”, aquaculture leads the growth ranking among the sectors of world food

production (Ahmed et al., 2019). Due to the rapid growth of the global human population, and the consequent increase in the demand for food, Kobayashi et al. (2015) and Ahmed and Thompson (2019) recommend the productive expansion of the activity, to balance supply chain management.

According to Tacon (2020), world aquaculture production was estimated at 111.95 million tons (Mt) in the year 2017. For comparative purposes, the activity exceeded wild catch fishing by 18.32 Mt, whose production was estimated at 93.63 Mt in the same period. The average annual growth rate of aquaculture is 6.13%, indicating market solidity and a trend of global appreciation in the aquatic organism sector (Tacon, 2020).

According to the Food & Agriculture Organization of the United Nations [FAO] (2021), the practice of Aquaculture differs from wild catch fisheries as it consists of the cultivation of aquatic organisms (fish, molluscs, crustaceans, aquatic plants, reptiles and amphibians). This implies interventions in the reproduction and growth of organisms, such as feeding and fattening, replacement after harvest and protection against predators, with the purpose of increasing production. In addition, wild-catch fishing is the exploitation of an aquatic resource as a common property, with or without appropriate licenses, while aquaculture must be in the possession of organizations such as companies and associations, adds the agency (FAO, 2021).

In Brazil, the number of aquatic farms was estimated at around 233,000 in 2017, as determined by Valenti et al. (2021) and originally published by the Brazilian Institute of Geography and Statistics [IBGE] (2020). In addition, these researchers cite that the volume produced exceeded 700 thousand tons, generating about U \$ 1 billion in gross revenue in the mentioned exercise.

Despite representing 12% of the world aquaculture gross revenue (Tacon, 2020), Oysters, Scallops and Mussels are responsible for only 1.86% of the financial volume produced by Brazilian aquaculture (IBGE, 2020a). This discrepancy may be indicative of the untapped opportunity to commercialize mollusks originating in national cultivation.

At this juncture, a socioeconomic highlight is the predominant small scale on Oyster, Scallop and Mussels farms, of which 50% have an area less than 1 hectare and 92% less than 5 hectares (IBGEb, 2020), which reveals a field in which plans for the expansion of business in the sector can be implemented.

Hopp and Greene (2018) consider that, if the plans are synchronized directly with other related activities, the viability of the risk is more likely. In the opinion of these

authors, the use of business plans in companies that use longitudinal data and, at the same time, control the development of their activities, is beneficial for planning short and medium term scenarios, but this result depends on the time invested in a project. plan and the existence of synchrony between it and the other management activities.

Competitions and competitions, in terms of the market, are dimensions that accurately portray the dynamics of the business environment and, above all, interfere in the life cycle of organizations. Thus, according to McKenzie and Sansone (2019), business plans are being used progressively in developing countries, in an attempt to stimulate entrepreneurship. However, these authors point out that these competitions usually attract competitors with growth prospects higher than the average of companies, because they disregard the use of prior planning that can be adopted and updated during insertion in the segment.

There are many recent studies on the theme of mariculture / aquaculture (Safford et al., 2019, Brown et al., 2020, Ren & Zeng, 2021, Gangnery et al., 2021, Brugere et al., 2021, Wang et al., 2021, Salayo et al., 2021), however, there is no evidence in the literature that focuses on a simplified business plan for planning and management in the sector.

Considering the exposed context, the objective of this work was to carry out a case study, by proposing a simplified business plan, in a small production of Oysters, Mussels and Scallops on the Brazilian coast.

II. THEORETICAL REFERENCE

In order to adapt to the size of the business and facilitate its reproduction, the theoretical framework of this work followed the simplification of the standard developed by the Brazilian Service of Support to Micro and Small Companies [SEBRAE] (Biagio, 2013). This standard contains the following themes in its structure, which will be detailed in the course of this section: Market Analysis; Marketing plan; Operational plan; and Financial Plan.

In market analysis, understanding the behavior of customers and suppliers is essential. Depending on the discovery by Johnsen et al. (2006), studies on the relevance of interactions with customers have been carried out extensively since the 1970s.

Cooil et al. (2007), in the same line as Henrique and Matos (2015), emphasize that attention to the client's characteristics - such as age group, educational level, income and gender - is decisive in the strategic adequacy of the business. The effect of adapting products and services to the profile of customers can result in satisfaction and loyalty of these users, in addition to

influencing their consumption behaviors. Specifically, obtaining customer loyalty is the target to be achieved and one of the main rewards of this method (Wolter et al., 2017).

Parallel to taking advantage of this opportunity, in allusion to the SWOT Analysis, understanding the competition is a key aspect in the planning and management of an enterprise. As studied by Gur and Greckhamer (2018), competitors can be identified by evaluating potential customers about products and services offered. Therefore, if two companies have solutions that meet the same needs of this audience, they can be considered competitors with each other.

In order to meet the level of service expected by the customer, and to gain an advantage over the competition, the selection of suppliers is an important stage of the process. As described by Cengiza et al. (2017), this component of Supply Chain Management must consider quality, delivery, price and capacity as priority criteria in the decision process among possible suppliers. Thus, structured studies of: technical acceptability of material, gross price, discount rate, net price, special charges, freight charges, total cost to destination, payment terms, scheduling, acceptance of project terms and conditions are recommended, promised delivery date based on the premium, shipping weight and expiration date of the quote (Cengiza et al., 2017).

As studied by Chernev (2020), a company's long-term and sustainable growth comes from planning that guides marketing activities. In summary, a company that does not have a growth-oriented strategy is more vulnerable to threats from its competitors, notes the author.

According to Marjanova et al. (2016), a marketing plan must contain marketing objectives, including product information, sales projection, profits and markets, promotional and advertising strategies, pricing policy, distribution channels, among others, with precise specification of deadlines and responsibilities.

The design of an adaptable and optimized layout is an important field of problems that has been investigated for several decades, say Herra et al. (2018). The parameters for determining solutions can include the analysis of the value flow, the incorporation of external suppliers or even the technical improvement of the employee.

Another aspect with high influence, in determining operational capacity, is the production system chosen: pulled, pushed and hybrid (Pinheiro et al., 2019). The systems are distinguished from each other, especially in decisions regarding the volume and timing of production. The pulled system is based on the client's request, mitigating excess risks, which implies a reduction in the

quantity produced and, consequently, in the costs involved. The pushed systems are characterized by the planning and release of production orders under demand forecasts, in order to guarantee an increase in the availability of products to the customer (Pinheiro et al., 2019).

According to Mazzarol and Rebound (2020), the fundamentals of a plan and financial management are present in the balance sheet accounting reports, income statement for the year and the cash flow statement. Without proper financial management, a modest expansion of finance-based operations can collapse the company's capital structure, even if sales increase. With the balance sheet report, short and long-term assets and liabilities are distinguished, providing the owner-manager with opportunities and restrictions for making assertive decisions, especially long-term ones such as debt.

Also, according to Mazzarol and Rebound (2020), the income statement for the year provides a breakdown of income and expenses for the accounting period, showing details of activities between the balance sheets. Its components make the entrepreneur capable of deriving several established performance metrics and, mainly, reacting to the results found.

The ability to monitor and predict cash flows is critical to the survival of a small business. By facilitating analyzes of the availability, sources and uses of business capital, it allows timely attention to deviations between the planned and realized flows. This operation can be performed by the cash flow report (Mazzarol & Rebound, 2020).

The growth and survival potentials of a small business depend on the owner-manager's expertise in assessing organizational financial performance. Therefore, some other indicators are suggested to improve these assessments.

For Calabrò (2017), break-even analysis has a wide variety of uses as an auxiliary tool for business and project management. It is worth highlighting some notable applications of this analysis, according to Morano and Tajani (2017): the dimensioning of demand and supply of products.; the analysis and definitions of the price policy and its effects on sales; the influence of the financial structure of project costs on the feasibility of the initiative; the comparison and choice between the technical and financial alternatives, the analysis of the stability of the results, as well as of the investment variables, and the effects on the convenience of the operators in investing their resources.

Profitability is also decisive for the performance of a small company (Mazzarol & Rebound, 2020). With it, it is possible to convert the company's value generation into a monitorable index, considering that it consists of the

capital earned from sales after deducting the corresponding costs. This metric is commonly used to compare the contribution of each product in the company.

In turn, El-Halwagi (2017) cites return on investment (ROI) as one of the recurring criteria in decisions about investments in new improvement projects or businesses. Each company must determine an ROI higher than the rate of inflation and interest associated with “safer” investments, to qualify it as viable. This metric weighs the expected return and the investments dedicated to a given action, being constantly indicated in the decision making about the allocation of resources.

III. METHODOLOGICAL APPROACH

The present work took place in an individual case study format at an Oyster, Scallop and Mussels farm, located in the state of Espírito Santo, Brazil.

In the understanding of Massis and Kotlar (2014), case studies are a research method that facilitates an in-depth investigation of a contemporary phenomenon in real life in its natural context. The case study research allows the exploration of the phenomenon under investigation, from a variety of perspectives, to obtain a balanced image in depth of the same event.

A proposal for the effective conduct of a case study, formulated by Miguel (2007), addressed the following steps: 1 - Definition of a Conceptual-Theoretical Structure; 2 - Planning of the Case (s); 3 - Conducting a Pilot Test; 4 - Data Collection; 5 - Data Analysis and; 6 - Generation of the Research Report.

Klaassen (2018) point out that the case study can, among other features, be used in situations where the main attributes of organizational and administrative processes, changes in general, international relations and business maturity are examined.

Analogous to Morgan et al. (2017) and Ridder (2017) illustrate that the face-to-face interview should be preceded by a research protocol, containing a data collection tool and the behavioral instructions for its application. Thus, the study design was traced; the strategy for carrying out the activities (pre-test, test and final questionnaire); type of data analysis implementation; ethical considerations and responsibilities.

This study considered the Likert scale in the interviews, whose planning methods were subjected to satisfaction assessment based on five points: 1 - Fully meets, 2 - partially meets, 3 - indifferent, 4 - does not partially meet and, 5 - does not meet totally).

Thus, in accordance with Miguel (2007), the Conceptual-Theoretical framework (Stage 1) was determined with the purpose of adapting to the market niche (micro and small companies), since the replicability of the SEBRAE business plan model is facilitated by the wide dissemination of information, compared to recent or sophisticated models.

Sequentially, there was the identification of a small company with potential for growth (Stage 2), whose owner was unaware of the method of building a business plan, but expressed interest in carrying it out. In compliance with the ethical precepts due, it was agreed to compartmentalize the study of the business (before and after) the existence of the simplified business plan.

In Stage 3, the AS IS and TO BE survey was carried out only for the first item (“Market Analysis”), in order to verify the quality of the information and, additionally, test procedures and adherence (pre-test).

Subsequently, corresponding to Stage 4, data were collected regarding all areas of the company, in order to conduct the intended business plan (test).

Stage 5 consisted of assessing the strengths and weaknesses in each area of the business (test). Thus, from the literature, we sought to build a robust planning, easily upgradable in electronic tools and self-explanatory, to the point of diagnosing and promoting the entrepreneur's market advances (final questionnaire).

IV. RESULTS

In accordance with the established methodological sequence, the evolution of business guidelines that occurred in the organization will be presented. It is worth highlighting the progress achieved with the proposal, which corroborates with the literature, with regard to the tangible and intangible gains in the preparation of the simplified business plan for the entrepreneur.

The presentation of the evolution will take place in a comparative way between the plans before and after the work for each of the macro themes raised in theoretical framework. The development of the business plan occurred in the Microsoft Excel tool, as shown in Figure 1.

Through this research, it was found that, prior to the formalization of the business plan, the entrepreneur's perception of potential customers, in his market analysis, was based solely on a problem of his own: he appreciates the consumption of fresh molluscs and does not find them with the desired ease. In other words, the analysis of the clientele would start only from an extrapolation of a specific feeling (frustration of the difficulty of consuming fresh mollusks) to the market, ignoring its variety of

characteristics, needs and additional ways of generating value.

In contrast, throughout the study and implementation of the business plan, demographic characterization, application of satisfaction questionnaires and monitoring of loyalty were able to determine possible opportunities and threats for gaining market share. Among the insights derived from the deepening of knowledge about the clientele, it is worth highlighting the need for diversification of mollusks to serve larger groups, as well as the increase in the level of service by delivery.



Fig. 1: Business Plan Menu.

The knowledge of the positioning of competitors occurred as a curiosity and was obtained in informal interactions with colleagues and potential customers. That said, no study was devoted to understanding the business's vulnerability to competition.

Throughout the study, new competitors, direct and indirect, were identified. As examples of this characterization, traders of crustaceans, mussels, octopuses and wild-caught squid stand out as indirect competitors.

The selection and contracting of the supplier of seeds for the cultivated molluscs, one of the main suppliers of the business, did not address quality proofs, leading to attempts at cultivation with a low survival rate. As a consequence of inadequate quality, there is an increase in expenses with seeds and losses due to unbalanced production capacity at different stages of management.

At the time of drawing up the business plan, a continuous and quality supplier had already been established. However, from a commercial point of view, objective criteria for quality assessment were defined, as well as a contingency measure plan for selecting substitute suppliers.

The company's marketing consisted of the informal dissemination of products in the nautical environment, frequented by the work team. Lacking any visual identity, the producer promoted the products through photos of the harvests on social networks. There was no methodology for pricing the products.

The business plan caused a price that is automatically adjusted due to cost variations. The resulting price adjustment guarantees the coverage of production costs, still remaining below the significant portion of competitors. Standardized promotional strategies started to be routinely disseminated on official cultivation advertising channels.

With regard to the operational plan, the production system was given in the fully pushed model, leading to losses in the finished product, given its perishability. In addition, post-handling logistical operations consisted of harvesting, moving products, storing in freezers and offering them to potential customers.

The model proposed in the planning relates to a hybrid system, the handling part of which is carried out according to the pushed model, while the harvest, logistics and commercialization are carried out in the pulled model, including the delivery mode.

The company's financial analysis consisted of just two matrices: one for expenses and the other for earnings. Both did not have the capacity to discriminate the period of occurrence of the financial transaction, being informed only the accumulated values.

From the implementation of the business plan, the feeding of financial data and reports was standardized via Microsoft Excel (see financial indicators in Figure 2 - Financial Indicators Pt. 1, and Figure 3 - Financial Indicators Pt. 2).

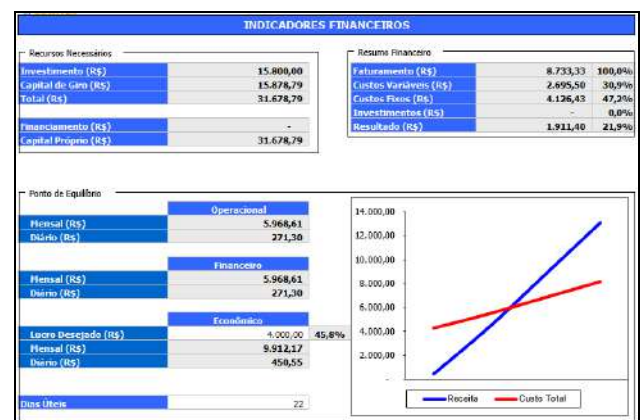


Fig. 2: Financial Indicators Pt. 1.

The business plan, in its entirety, provided the owner-manager with the knowledge that it would be above its break-even point. With that, the security of the return of his effort also brought to the owner-manager the intangible gain of greater enthusiasm, decisive in the success of new ventures.

The business presented 47.2% of its revenue as a fixed cost; 30.9% as a variable cost, 0.0% as a financial cost and 21.1% as a result. Thus, the estimated payback time in a scenario without production expansions was 17 months. However, the low representativeness of variable costs suggests that increases in production may favor the owner-manager.

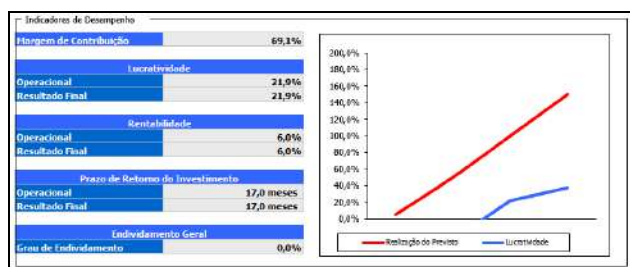


Fig. 3: Financial Indicators Pt. 2.

V. FINAL CONSIDERATIONS

Planning, regardless of its format, is indispensable for the sustainable development of any enterprise. In this work, a simplified business plan model was adopted, which proved to be able to balance the difficulty of planning and the harvest of good fruits by the owner-manager, in the branch of aquaculture of mollusks.

In order to contribute with the objective of maximizing the value generated to the business stakeholders, the present work sought to standardize the most pertinent analyzes of the literature, in order to shape and facilitate new updates and, simultaneously, maintain the capacity of planning review without burdening the owner-manager in doing so.

Through the aid of research on theoretical frameworks and practical application of the information found, it was possible to generate knowledge for the organization, standardizing the definition of strategies for its strengthening and growth, which enabled it to achieve the objective set for the work.

The benefits achieved were: the empirical demonstration of the business plan theory; providing support for planning reproduction by other producers in this expanding market; and strategic gains for the entrepreneur who owns the farm.

Finally, the plan made it possible to actively integrate the market, not allowing significant unforeseen events or

maladministration to put its production in check, as it translates as a document that characterizes the way of operating, strategies and projections of expenses, revenues and other results. financial resources.

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Industry 4.0 Machine Learning to Monitor the Life Span of Cutting Tools in an Automotive Production Line

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Abstract — The evolution of manufacturing processes in the global industrial scenario is correlated with the growing integration of information technologies, storage capacity and data processing, effective communication between sectors and the development of intelligent and autonomous lines that seek zero waste and quick take-up. decision. In the productive sphere, the use of these resources characterizes intelligent factories, where the manufacture of physical objects is integrated into the information network. Industry 4.0 provides a more flexible, sustainable and agile production chain prioritizing autonomous decision-making integrating hundreds of thousands of generated data and machine learning for problem solving, process improvement and agile and absolute productive monitoring. The present study seeks to prove how decision making through supervised machine learning programming models contributes to cost reduction, increased productivity, waste elimination and process improvement in monitoring tool life in cutting tools used in machining lines process for the manufacture cylinder blocks and cylinder heads of combustion engines in the automotive sector. The knowledge generated from this study reinforces the need and relevance of the concept's dissemination of the fourth industrial revolution in the country, an industrial trend adopted globally in recent years.

I. INTRODUCTION

Since the beginning of the industrial age, three industrial revolutions have been witnessed. Until in 2011 in Hannover Germany, industry 4.0 or fourth industrial revolution, began to gain prominence on the world stage [1].

The fourth industrial revolution model proposes the integration of man-machine-data analytics [2]. Faster and smarter decisions from integrated concepts of Internet of Things IoT, Cyber-physical systems, data analytics and machine learning [2]. Countries with strategic plans for implementing Industry 4.0: Industry 4.0 program in Germany, Industrial Internet plan in the US, and the Internet+ or Made in China 2025 plan [3]. The benefits

that the implementation of Industry 4.0 concepts can provide for the machining industry: increased productivity, preventive maintenance and diagnostics, fault detection, monitoring of process cutting tools, vibration detection among others [4].

Among the objectives of this article are to prove how the application of machine learning and remote data analysis for decision making in optimizing the life of cutting tools used in the machining process in the automotive sector aiming at the implementation of Industry 4.0 in manufacturing.

Investigate the theoretical concepts and tools needed to evaluate the relevance of machine learning and remote data analysis for efficient decision making in the process.

Present the results obtained in productivity and cost reduction with the use of Industry 4.0 for monitoring the life of cutting tools in the machining process for parts in the automotive sector.

Score the difficulties and barriers to implementing the concepts of industry 4.0 in the machining processes of the automotive sector.

According to data from [5], Brazil currently ranks 69th in the global innovation index showing a 7% decline in positions in the ranking of innovation efficiency and productivity of industries between the period from 2006 to 2016. The benefits for the academic and industrial area point out that the use of Industry 4.0 concepts should offer production engineering sectors an integrated chain, agile, without waste and able to make faster and more effective decisions.

II. THEORETICAL BACKGROUND

Industry 4.0 seeks to deal with global challenges, to generate competitive strength for organizations, considering the globalization between markets [6].

The integration that industry 4.0 provides, using real-time information to generate new business models, to individualize products and services allows the organization to control the value chain by connecting human capital with objects and system [7].

Internet of things (IoT) is an integration of emerging technologies that establishes a new path for industrial production systems [1].

IoT enables physical devices (sensors, actuators, meters, etc.) to connect into a network to exchange information and supply data. These technologies are the foundation of IoT as a network of connected devices that generates the supply data for the enterprise using big data [8].

Cyber-physical system (CPS), or cyber-physical systems are characterized as computer (cyber) systems that act within a mechanical or electrical (physical) system, intended to perform specific dedicated functions with real-time computing constraints. According to this conception, in CPS, multiple devices are networked to detect, monitor, and act on physical elements [9].

Artificial intelligence is the field that seeks to study the creation of agents with intelligence, which have the goal of approaching human intelligence, providing autonomy for a machine or system to be able to make decision based on training of hypothetical models dispensing human interaction [10].

- Enable self-organized production system;

- Intelligent monitoring and diagnostics;
- Agile and accurate decision making;
- Failure prediction.

Artificial neural network (ANN) is a mathematical computational model inspired by the structure and/or functional aspects of biological neural networks. In most cases, an ANN is an adaptive system capable of changing its structure based on external or internal information flowing through the network during the learning phase [11].

Machine learning, machine learning (ML), is a methodology that uses an algorithm capable of recognizing data patterns and making predictions. It is a tool of great potential in various areas of the production system. Machine learning categories are divided into: supervised learning: the machine is trained with data and its respective correct answers; unsupervised learning: it develops the algorithm to predict an outcome not known and reinforced learning: the algorithm is penalized for its actions through trial and error [12].

Python™ is an open source software development platform, which makes it freely usable and distributable, even for commercial purposes. Python's license is administered by the Python Software Foundation. The language was developed by Guido Van Rossum in 1990 and the adoption of the language is constantly expanding in the areas of data science, machine learning, big data and web development. Currently the language is expanding in technology companies such as Google, Yahoo, Microsoft, Disney, Air Canada, BitTorrent and others [13].

Cutting tools - Machining is a manufacturing process that generates shape, dimensions and surface finish to a formed part by the removal of material in the form of chips. The interference between the cutting tool and the workpiece during the machining process is responsible for the removal of material called chips. A cutting tool is made of a material with good thermal conductivity, specific heat and thermal expansion, mechanical strength, abrasion resistance and hardness higher than the material to be processed [14].

Machining operations are widely used in the manufacturing industry on components that require precision and quality surface finish. As it is a widespread operation in the industry with its processes established years ago, machining can provide low operating costs when ensured the best condition of process, machine, tool, cooling, cutting parameters, among others [15].

The lifetime of a cutting tool is by definition the time it works until it loses cutting ability according to an established specification. After this time, which can be

determined by means of the number of pieces, the number of operations performed or converted into linear meters, the tool must be replaced or sent to the re-sharpening process [16].

For cutting tools, the end of useful life occurs due to wear on the cutting edge due to contact with the workpiece during machining. The wear can be accentuated due to incorrect cutting parameters that contribute to the formation of a false cutting edge that accelerates the edge wear process. The dimensional accuracy and surface quality of the final part may be affected, since the roughness will be higher due to the use of a worn tool. This continuous use of a cutting tool, which has already reached its established useful life, can generate not only problems related to the quality of the part, but also tool breakage making its re-sharpening unfeasible in certain cases [17].

A wear occurs from the continuous and microscopic loss of particles from the tool edge as a result of cutting in the machining process. Wear is classified as flank or frontal wear: which occurs on the clearance surface of the tool as a result of contact with the workpiece, this being the most common occurrence; notch wear: where the wear occurs at both ends of the tip changing the shape of the tool tip and influencing the finish of the machined surface and crater wear or cratering: which can occur on the exit surface of the edge due to friction between tool and chip, the growth of this type of wear can lead to tool breakage [16].

Besides the classified wear, there are also the failure mechanisms that are processes that fatigue the cutting edges, consequently leading the edge to wear and have its continuity of cutting unfeasible. Among the most frequent malfunctions we can cite the false cutting edge, where the chips detached from the cutting process are welded by pressure on the edge and change the geometry of the edge, preventing the correct cut. Thermal cracks that arise due to temperature variation during machining and chipping on edges that is the result of overloading by mechanical tensile stresses during the process are also considered malfunctions [18].

Tool life is directly dependent on the level of tool wear. To control the tip surface conditions and the prediction of machining time the level needs to be carefully established. There is a body of research on tip wear that reports prediction methods for tool life and cutting conditions in order to prevent catastrophic wear [19].

III. METHOD AND MATERIAL

The data used for this research were collected by the team responsible for managing the machining processes and cutting tools of the automotive company located in Vale do Paraíba – São Paulo - Brazil. We considered the life cycle data obtained through the global tool setting variset (GTSv) cutting tool management system used in the plant from the machining operations of blocks and cylinder heads used in the assembly of three-cylinder engines, where the information of life cycle, the causes of tool change, machine, operation, shift, date and time of change correspond to a production of approximately ninety thousand blocks and cylinder heads manufactured from January to December of 2020.

The raw parts of the cylinder blocks and cylinder heads are cast in aluminum with some specific areas according to the product design reinforced in sintered steel, such as the cylinder housings and crankshaft bearing supports in the cylinder blocks and the combustion valve guides and seats in the cylinder heads. The raw parts are forwarded to the machining processes on their respective lines.

The cutting tools involved in the machining processes of engine blocks and cylinder heads are bars with interchangeable cubic boron nitride (CBN) and carbide (tungsten carbide and sintered cobalt) inserts for machining internal diameters with the need for high abrasion resistance, carbide drills and reamers for precision hole making, carbide taps for threading processes, endmills and reamers made of polycrystalline diamond (PCD) material highly used in aluminum machining processes as it offers higher productivity due to the high cutting parameters employed.

The cutting tools, before being sent to the machining operations, are prepared in the presetting room according to process specifications. That is, tool heights are adjusted to avoid collisions, cutting knife diameters and when necessary according to the type of tool, the number of inserts required for each machining sequence.

After the physical adjustment and correction of the tool dimensions in the presetting machine, the tool identification information, expected tool life, coolant pressure to be used, machining operation and line, and preset data are recorded. This information is recorded according to a standard map established in the recording tag.

This recording is performed by the presetting machine, which has in its database the preset programs with all the necessary information for each tool in the process. After adjusting the tool, the recording is done on its tag, a Balluff chip of the low frequency - radio frequency identification (RFID BIS C) type that uses two frequency

bands: 455 kilohertz (kHz) for recording and seventy kHz for reading. Recording is essential to the process, because when replacing the tool, the machine must recognize the information recorded to continue the operation. Once the recording is done the machine will print a tag with the basic information that is confronted in the machine after reading the tag at the moment of tool replacement.

After the tool reaches its end of life or if its premature replacement is necessary, the machine will re-record the last information in the tag's internal map so that this data can be returned and stored in the tool change history, helping in the management. The output information is: the reason for the tool change, the achieved tool life, the expected tool life, the machine, the operation, the time and the shift of the tool removal. All other original preset and tool identification information initially saved before machine entry is retained.

The tool life accounting system used in the plant is called GTSv. It is a multitasking resource used by the tool managers that allows monitoring and storing the tool life history, by means of occurrence information and reports of unscheduled changes and their several reasons, tool breakage and tool life alteration by engineering request. The tool life management occurs from the information supplied and stored, after each tool change in the process. In addition to the tool life monitoring features of the operations the system allows:

Inventory control:

- Define and view stock locations in the plant;
- Check quantity assigned to a location;
- Check total plant quantity;
- Check maximum and minimum stock quantities;
- Generate inventory control reports;
- Monitor quantities of components available;
- Generate inventory automatically;
- Extract stock from various locations;
- Integration with the supply chain to schedule tool purchases.

Multi-Action Set:

- Creation of dynamic product trees;
- Reporting of cutting tools that have not reached useful life;
- Reporting of tools with high consumption per operation;
- Feature to monitor tool life online;
- Monitor total and unit tool costs according to consumption and tool life.

The feature to monitor tool life online through live view, integrates the control system of parts produced by the factory information system (FIS) that has connectivity on the machines with the GTSv. This allows anyone with access to the GTSv to view in real time the tool life of any tool in the process. This feature facilitates the availability of the tool on the machine for its replacement at the correct time, avoiding unscheduled changes before the end of the tool life and the correct programming of the tool preset time.

The FIS system is responsible for monitoring the plant's production equipment, and its main function is to follow up bottleneck operations, the daily production volume to be reached, the verification of production and maintenance indicators. The production line machines communicate with the FIS by means of sensors connected to a wireless network, transmitting to the system the machine availability for each machined part. The GTSv in its live view feature uses this information in real time to check how many parts a particular tool has produced.

The computer numerical control (CNC) machining centers used in the engine block and head lines are the G500 type from the manufacturer Grob. The machines have a modular horizontal machining pattern and articulated table suitable for flexible mass production of automotive components such as cylinder blocks and cylinder heads. The machines have gantry-type automation part loading, where automated robots travel down the line through portals supplying the machines with parts operation after operation.

Through the cyber-physical system (CPS) the electronic sensors of the machines send the tracking signals to the cloud. This data is interpreted by the FIS. Thus the engineers responsible for the line keep track of the bottleneck operation, the machines in shutdown, the failures that occur throughout the process and that need maintenance intervention, and the volume produced.

The integration between machines and systems is the first step required to use IoT resources and store data that will serve as the basis for machine learning.

Tool life is the average time the tool will work until it reaches the maximum allowable edge wear without presenting irreversible damage to the tool such as breakage or affecting product quality. However, in addition to the wear and quality factor there is another important point to be considered in tool life: the cost.

The tool cost per unit produced, called tool CPU, is summarized as the number of parts that the tool is capable of producing (tool life) divided by the unit cost of this tool. Therefore, the more parts a tool is capable of producing, the lower its cost per unit produced and the higher its

productivity, since the tool will remain in operation for longer, reducing the machine stoppage for replacement, which impacts the cycle time of the process.

Through the history stored in the GTSv it is possible to analyze the behavior of the useful life of each process tool. For the cases in which the tool does not reach or there is a great variation of useful life, the stored information will be the base to start the study to verify the cause of the problem and correct it. For the cases in which the tool behaves according to the expected useful life, not generating occurrences of breakage or early replacement, it is possible to start a study to increase its useful life with the objective of reducing its tool CPU and increasing its productivity.

This study is conducted by analyzing the tool life achieved over a certain period of time and monitoring the wear of the cutting edge, to ensure that the initially proposed tool life will not present a critical wear that will prevent the extension of the cutting condition of the edge. After this initial analysis, a longer life is proposed and the edge wear is monitored during the test, if the wear remains stable the new life will be approved and changed throughout the process.

However, this test period can take months to complete. There are tools that have an initial useful life with high values and the test will depend on the volume to be produced over the months. In periods where the scheduled production is lower, more time will be needed to validate the new life under test.

The literature reinforces that cutting edge wear varies as a function of the cutting parameters used and as a function of the time the tool remains cutting. The stages of wear as a function of time can be predicted by considering the use of correct cutting parameters. Initially the wear tends to grow rapidly for a short period once the tool starts machining, after this period the wear stabilizes presenting a steady and controlled increase until it reaches its maximum breaking point where it will not be recommended to extend the tool life without offering risks to product quality and tool breakage.

For cases where the cutting parameters are already consistent with the process needs and the initial tool life is constantly reached, it is possible to start the gradual increase of tool life and then validate the wear without offering risks to production.

The assessment of tool life generally requires significant time and material resources, and is therefore considered a relatively expensive procedure. Hence, the importance of accurately predicting tool life and preparing replacement schedules before defects or catastrophic wear brings the process to a halt. Furthermore, accurate tool life

is crucial for optimizing the cutting productivity and cost of machining processes.

Increasing the scope of automated transformation processes will, at all times, have to meet the highest requirements in terms of reliable tool life predictions. That is, from the connectivity features between machine, FIS and GTSv commented in this chapter it is possible to teach the machine to analyze the cases in which a given tool will complete the tool life constantly and make the decision of the gradual increase according to the stored database.

3.1 Development of the PYTHON™ model

The Python™ development platform that has its license administered by the Python Software Foundation (PSF) has a relatively simple language, an extensive library that allows to elaborate new applications using open source code. In addition to having a language that facilitates programming, Python is a distributable software, available for download and installation of its libraries directly from the PSF website.

Through its simple language it is possible to elaborate simple classification algorithms such as for example the detection of spam and non-spam e-mail, or to predict a sale from the user's profile. The possibilities when it comes to classification are unlimited.

In the manufacturing context, classification within supervised learning is one of the most used methods of machine learning, because it allows to identify to which category a certain information belongs and "train" the machine to be able to differentiate the received information according to a database previously analyzed.

This method was chosen to validate the idea of increasing the life of cutting tools used in the manufacturing processes of blocks and cylinder heads of three-cylinder engines. For this, data was collected from ninety cutting tools that were removed from the machining machines for reaching or not the previously established useful life throughout the year 2020 and directly linked to the volume of ninety thousand blocks and cylinder heads produced.

IV. RESULTS AND DISCUSSION

This Initially, the database was made up of the date and time of the change, a descriptive summary of the tool identification (line identification - operation - tool code), the reason for the tool change, the expected useful life, the useful life accomplished, the type of change, the operation and the machine located.

Table 1 exemplifies the information surveyed between January 06 and 13, 2020 for the test tool DB-050-01-

T5012, the tool identification reference follows the following order of information:

- DB - Refers to the machining line, where DB indicates block machining line and DH head machining line;
- 050 - Informs the machining operation, in this case operation 50;
- 01 - Informs the position in the tool magazine, in this case analyzed refers to the first position of tool storage in the magazine;
- T5012 - Informs the tool identification number.

The data management software, GTSv, establishes a tolerance of up to -10 pieces to consider that the tool life is completed, in this example of Table 1 the expected tool life is 200 pieces, but in the cases where the tool reached up to 190 pieces it is considered completed tool life. This tolerance exists to prevent the machine from being idle waiting for a tool, with this tolerance the operator will have enough time to inform about the need to change the tool without the need to leave the machine in shutdown waiting for a tool.

Table 1: Collected data to build the Big Data

Change Date	ID	Reason	Expected Count	End Count	Op	Mac	End Life
1/6/20 15:42	DB-050-01-T5012	Scheduled	200	200	050	050.1	Complete
1/8/20 21:31	DB-050-01-T5012	Scheduled	200	200	050	050.3	Complete
1/8/20 21:32	DB-050-01-T5012	Scheduled	200	200	050	050.1	Complete
1/9/20 8:36	DB-050-01-T5012	Scheduled	200	108	050	050.2	Incomplete
1/9/20 16:38	DB-050-01-T5012	Scheduled	200	195	050	050.4	Complete
1/9/20 19:55	DB-050-01-T5012	Scheduled	200	194	050	050.1	Complete
1/9/20 23:49	DB-050-01-T5012	Scheduled	200	194	050	050.3	Complete
1/10/20 17:11	DB-050-01-T5012	Scheduled	200	196	050	050.2	Complete
1/13/20 7:33	DB-050-01-T5012	Scheduled	200	135	050	050.1	Incomplete
1/13/20 13:18	DB-050-01-T5012	Scheduled	200	146	050	050.2	Incomplete

After the survey and filtering of the initial data, excluding inaccurate information from the collected data, the classification step of tools that reached the programmed useful life and the tools that did not reach it was performed to assign in binary language a value that we will use in the programming to identify the two cases.

Next, the binary classification was performed through Microsoft Excel using a condition function, of type "IF" establishing "1" for complete useful life and "0" for incomplete useful life. Table 2 illustrates the addition of the binarization information in the example in Table 1 for the DB-050-01-T5012 tool.

Table 2: Classification of the tool life in binary numbers and the tool change time

Change Date	ID	Reason	Expected Count	End Count	Op	Mac	End Life	Binary
1/6/20 15:42	DB-050-01-T5012	Scheduled	200	200	050	050.1	Complete	1
1/8/20 21:31	DB-050-01-T5012	Scheduled	200	200	050	050.3	Complete	1
1/8/20 21:32	DB-050-01-T5012	Scheduled	200	200	050	050.1	Complete	1
1/9/20 8:36	DB-050-01-T5012	Scheduled	200	108	050	050.2	Incomplete	0
1/9/20 16:38	DB-050-01-T5012	Scheduled	200	195	050	050.4	Complete	1
1/9/20 19:55	DB-050-01-T5012	Scheduled	200	194	050	050.1	Complete	1
1/9/20 23:49	DB-050-01-T5012	Scheduled	200	194	050	050.3	Complete	1
1/10/20 17:11	DB-050-01-T5012	Scheduled	200	196	050	050.2	Complete	1
1/13/20 7:33	DB-050-01-T5012	Scheduled	200	135	050	050.1	Incomplete	0
1/13/20 13:18	DB-050-01-T5012	Scheduled	200	146	050	050.2	Incomplete	0

From the binary classification data, the process of data interpretation was started through conditional structures in Python language. These routines will show that the program can interpret and differentiate the cases in which the automatic lifetime increase should occur.

The conditional routine will receive the information of anticipated tool change, before completing the useful life represented by 0, or tool change by completed useful life, represented by 1. Table 3 presents the accounting of tool changes DB-170-04-T17004 of the block machining line in operation 170, which occurred throughout the year 2020, all changes were according to the completed useful life.

Table 3: Tool changes DB-170-04-T17004

Change Date	ID	Reason	Expected Count	End Count	Op	Mac	End Life	Binary
1/9/20 17:20	DB-170-04-T17004	Scheduled	2000	1995	170	170.1	Complete	1
1/10/20 19:32	DB-170-04-T17004	Scheduled	2000	1991	170	170.2	Complete	1
1/10/20 19:33	DB-170-04-T17004	Scheduled	2000	1998	170	170.3	Complete	1
1/13/20 20:22	DB-170-04-T17004	Scheduled	2000	1995	170	170.4	Complete	1
1/30/20 07:46	DB-170-04-T17004	Scheduled	2000	1999	170	170.2	Complete	1
2/20/20 20:28	DB-170-04-T17004	Scheduled	2000	1997	170	170.1	Complete	1
2/20/20 21:34	DB-170-04-T17004	Scheduled	2000	1998	170	170.2	Complete	1
2/20/20 22:23	DB-170-04-T17004	Scheduled	2000	1998	170	170.3	Complete	1
7/16/20 21:32	DB-170-04-T17004	Scheduled	2000	2493	170	170.2	Complete	1
8/3/20 21:04	DB-170-04-T17004	Scheduled	2000	2675	170	170.4	Complete	1
10/6/20 17:00	DB-170-04-T17004	Scheduled	2000	2993	170	170.2	Complete	1
11/9/20 13:53	DB-170-04-T17004	Scheduled	2000	2618	170	170.3	Complete	1
11/17/20 19:07	DB-170-04-T17004	Scheduled	2000	1995	170	170.4	Complete	1
12/7/20 19:12	DB-170-04-T17004	Scheduled	2000	1993	170	170.1	Complete	1

Fig. 1 illustrates the automatic tool life increase condition for tool DB-170-04-T17004 suggesting the tool life increase by 10%, as all changes were according to the completed life.

```

In [6]: # changes from DB-170-04-T17004
# current tool life 2000 parts

toolchange = [1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]
if toolchange == [1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]:
    toollife = 2000*1.1 #10% improvement
else:
    toollife = 2000
print(toollife)

2200.0

```

Fig. 1: Conditional Code in Python for tool DB-170-04-T17004.

The next case analyzed does not present several tool changes due to the fact that the reported tool life is higher than the case presented in Fig. 1, however the conditional routine works the same way. It is known that in specific cases, such as PCD tools, it is possible to reach, in certain cases, about 50% of increase in the tool life due to the wear resistance presented by the tool in stable processes.

Table 4 presents the analyzed information of the DH-120-11-T12010 tool of the head machining line in operation120, occurred throughout the year 2020, all four changes were according to the completed service life.

Table 4: Tool changes DB-120-11-T12010

Change Date	ID	Reason	Expected Count	End Count	Op	Mac	EndLife	Binary
10/8/20 14:17	DH-120-11-T12010	Scheduled	25000	24092	120	120.2	Complete	1
2/19/20 12:49	DH-120-11-T12010	Scheduled	25000	25000	120	120.1	Complete	1
12/7/20 20:35	DH-120-11-T12010	Scheduled	25000	25000	120	120.4	Complete	1
10/8/20 14:16	DH-120-11-T12010	Scheduled	25000	24092	120	120.3	Complete	1

Fig. 2 illustrates the automatic tool life increase condition for the DB-120-11-T12010 tool suggesting the life increase by 10% due to the changes occurring according to the completed life.

```

In [5]: # changes from DH-120-11-T12010
# current tool life 25000 parts

toolchange = [1, 1, 1, 1]
if toolchange == [1, 1, 1, 1]: # changes from DH-120-11-T12010
    # current tool life 25000 parts
    toollife = 25000*1.1 #10% improvement
else:
    toollife = 25000
print(toollife)

27500.0

```

Fig. 2: Conditional Code in Python for tool DH-120-11-T12010.

The cases in which the tool presents variation in changes due to completed service life and early changes, the condition of the routine indicates the permanence of the service life at the current value. Table 5 presents the information analyzed for tool DB-050-04-T5004 of the

block machining line in operation 50, where the changes occurred throughout the year 2020.

The reason for the six changes ranged from end of life to early tool change, which may indicate a quality or process problem involving the tool where a decision was made to replace it with a new one.

Table 5: Tool changes DB-050-04-T5004

Change Date	ID	Reason	Expected Count	End Count	Op	Mac	EndLife	Binary
1/16/20 21:12	DB-050-04-T5004	Scheduled	7000	6998	050	050.1	Complete	1
3/16/20 20:15	DB-050-04-T5004	Scheduled	7000	9998	050	050.3	Complete	1
8/14/20 07:42	DB-050-04-T5004	Scheduled	7000	4192	050	050.4	Incomplete	0
10/6/20 17:02	DB-050-04-T5004	Scheduled	7000	6657	050	050.3	Incomplete	0

Fig. 3 illustrates the veto of the automatic tool life increase condition for tool DB-050-04-T5004 maintaining the current life value as a function of unscheduled changes.

```

In [7]: # changes from DB-050-04-T5004
# current tool life 7000 parts

toolchange = [1, 1, 0, 0]
if toolchange == [1, 1, 1, 1]:
    toollife = 7000*1.1 #10% improvement
else:
    toollife = 7000
print(toollife)

7000

```

Fig. 3: Conditional Code in Python for tool DB-050-04-T5004.

Condition routines associated with repetitions, which are used to execute the same part of a program, is an alternative to prove through Python that it is possible to make decisions of a certain automatic lifetime increase when a tool analyzed for a period always completes its lifetime without generating quality or process problems.


However, when it comes to machine learning, the ideal is to develop a model by means of an algorithm that will train the machine to make these decisions automatically.

From the same information presented it is possible to create a Bayesian type algorithm, called naive_bayes, which will perform the machine training from the classification data. This multinomialNB, NB (naive bayes) algorithm is available in sklearn's Python library.

Once the model is trained to fit the data and markers, it is necessary to implement the prediction method to the model to predict which element we want to be discovered or which decision to make. This is done using the predict method.

Fig. 4 presents the idea of the model to train the program to classify between two tools which one will fit the increased lifetime automatically. This is the starting

point for the implementation of machine learning. In the example between tools T12009 and T12010, tool T12010 has all four end-of-life replacements, and tool T12009 among its four replacements there was an early replacement indicating some problem associated with the tool. Therefore, the model should choose tool T12010.



```

In [*]: # Predict test to implement tool increase

T12009 = [1, 1, 0, 1]
T12010 = [1, 1, 1, 1]

dados = [T12009, T12010]
marcacoes = [1, -1]

ToolIncrease = [1, 1, 1, 1]

from sklearn.naive_bayes import MultinomialNB
modelo = MultinomialNB()
modelo.fit(dados, marcacoes)
print(modelo.predict(toolincrease))

T12010

```

Fig. 4: Classification modeling within tools classes for the life time increasing.

The model for predicting the automatic tool life increase is the first step in the implementation of the supervised learning classification concepts. For the complete implementation of the presented theory it is necessary to perform a systemic work integrating the cyber-physical systems of the CNC machining centers, the sensors used during the machining execution and the network interpreting the data. So that besides learning the classification differentiation, the machine also executes the decision made and provides new data for monitoring the process closing the ideal industry 4.0 chain.

Analyzing the achieved data of increased lifetime of cutting tools in an automatic way by means of a model to simulate machine learning, the results of cost reduction and productivity increase of the involved cutting tools and that supplied the exchange data to the database were verified.

From the implementation of the decision making model of the tool life increase involved in the research through machine learning, it is possible to estimate that after the developed and implemented project there will be a reduction in the tool unit cost (tool CPU) of the machining lines and an increase in productivity due to the larger quantity of parts produced by each tool.

The estimated saving of the tool CPU is presented in Table 6, where the increase in the useful life of the tools involved in the process was considered to be about 10%. These data reinforce the economic feasibility for the company from the implementation of the proposed model, where the cost reduction as a function of the annual volume of ninety thousand engines can reach R\$170,000.00.

Table 6: Cost saving expectation by the modeling implementation

Machining Line	Tool CPU	Tool CPU Less 10%	Saving	Saving 90 Engines
Cylinder Head	R\$ 8,67	R\$ 7,80	R\$ 0,87	R\$ 78.300,00
Cylinder Block	R\$ 9,60	R\$ 8,58	R\$ 1,02	R\$ 91.800,00
			Total Saving	R\$ 170.100,00

It is worth pointing out that the values presented are estimates from the proof of the model. It is necessary to implement and develop the model so that it converses with the cyber-physical system of the machines and machine learning occurs automatically. In addition to the economic results suggested through this research, it is important to note that the theoretical concepts and the use of Industry 4.0 concepts were fundamental to the application of machine learning and remote data analysis for efficient decision making in the process. Which reinforces the relevance and trend of the subject in the industrial and academic scenario of the production engineering field.

V. CONCLUSION

This research sought, based on the knowledge generated, to present satisfactory data to answer the fundamental questions that permeated the study. It was proven that from the development of a supervised machine learning model with routines for verification of tool life increase it is possible to reduce process costs by guaranteeing the extension of tool life and making it possible to increase productivity. Through the study developed and the results obtained, it was possible to validate and prove the importance of data analysis and machine learning for efficient decision making in manufacturing processes in the automotive sector. The use of the concepts of Industry 4.0, machine learning, and modeling were essential to establish considerable gains in productivity and the reduction of cutting tool costs in the machining processes.

The practical implications of this study contribute to the dissemination of fundamental knowledge of research sectors in increasing rise in the world industrial scenario, such as industry 4.0, the use of artificial intelligence in production chains through machine learning, and the search for efficiency of machining processes highly used in the automotive sector, aiming at continuous cost reduction and increased productivity.

The limitations are centered on the need to continue the development of the model presented, so that the machines in the process are able to classify the cases liable to increase the tool life and execute the decision made without the need for human interference. For this it is important to seek ways to integrate the cyber-physical

systems of the CNC machining centers, the sensors used during the machining execution, and the data network.

It is suggested for the development of further research from this generated knowledge, the development of the classification algorithm for machine learning through the creation of a cloud-based neural network for intelligent online diagnosis that allows the monitoring of the cutting tool during machining.

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Critical Illness Polyneuropathy: Case Report and Update

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Keywords— Polyneuropathy; Systemic inflammatory response syndrome; Sepsis; Critical patient.

Abstract — Asthenia is a manifestation commonly found in critically ill patients hospitalized in an intensive care unit. In addition to the hard weaning from invasive mechanical ventilation, it is essential to recognize Critical Patient's Polyneuropathy (CPP). Case Report: JCD, 63 years old, white, single, obese (BMI> 40), type II diabetic controlled with diet and Metformin 2g / day, mild hypertension, with hyperuricemia (gout). Former smoker and social drinker. A clinic of severe abdominal pain, in bar type, appeared on the upper region of the abdomen on 07/07/2018, with a diagnostic hypothesis of urolithiasis and urinary infection. He was admitted on 10/07/2018 with an abdominal septic shock / cholecystitis. He remained on mechanical ventilation and use of amines for a long time, was tracheostomized and managed to decanulate. During this period, he developed ARDS lung, acute dialysis renal failure (recovered renal function), drug hepatitis and critical patient's polyneuropathy. Discharge from ICU on 28/09/2018. The examination reveals tetraparesis with a predominance of the distal, brachial and crural thirds; stylo-radial and flexor reflexes of the left hypoactive fingers, patellar hyporeflexia, abolished aquileus; superficial sensitivity: thermal and painful tactile hypoesthesia with paresthesia on the feet soles; profound sensitivity: proprioceptive hypoesthesia and hypopalesthesia in the distal third of the 4 limbs; in addition to flaccid paraparetic gait. Lumbar puncture, ENMG and biopsy of the sural nerve. In the CSF, there was an absence of leukocytes, normal glucose and 20mg / dL proteins. The ENMG showed axonal motor sensitive polyneuropathy, with decreased potential amplitudes. Discussion: Critical Patient's Polyneuropathy is a predominantly motor condition, however, related to sensitive, symmetrical and acute impairment associated with exaggerated systemic inflammatory response syndrome (SIRS), which

mostly occurs in cases of sepsis. There is widespread asthenia and difficulty in weaning from invasive mechanical ventilation as the two peculiarities sine qua non for the identification of patients with CPP. The diagnosis of CPP is by exclusion. Electroneuromyography, in turn, is defined as the gold standard exam. Conclusion: Despite its occurrence, elements that are objectively related to its pathophysiology remain hidden. For this reason, the importance of further studies regarding the risk factors and diagnosis of CPP is reiterated in order to optimize the identification and the control of the severity of the affected patients.

I. INTRODUCTION

Asthenia is a manifestation commonly found in critical patients hospitalized in the intensive care unit (ICU), occurring in about 46% of patients hospitalized in the ICU^{1,2} and who were exposed to the following risk factors: systemic inflammatory response syndrome/sepsis; multiple organ failure; hyperglycemia; dialysis; administration of vasoactive drugs, such as catecholamines; women; high mechanical ventilation time; use of corticosteroids; neuromuscular blockers. In addition to the hard weaning from invasive mechanical ventilation, it is essential to recognize Critical Patient's Polyneuropathy (CPP).³

There are reports of two comorbidities responsible for the generalized weakness that affect patient admitted to the ICU: Critical Patient's Polyneuropathy (critical illness polyneuropathy),⁴ with acute polyneuropathy that most affects these patients, and critical myopathy (critical illness myopathy), which refers to muscle impairment primarily, with no nerve damage.⁵

Since the 1970s, neuromuscular function disorders have been recognized as the main cause of generalized asthenia, in addition to prolonged invasive mechanical ventilation (IMV), due to nerve and muscle damage in patients in the ICU. Such obtained muscle weakness is not only related to loss of muscle mass due to the long period of immobility or seriousness of the underlying pathology, but also to polytrauma, multiple organ dysfunction or severe infections, highlighting that the permanence, as well as the progress of illness resulting from hospitalization and the established treatment can provide the development of Critical Patient's Polyneuropathy.^{6,7}

The term "Critical Patient's Polyneuropathy" has an axonal nature, mostly motor, symmetrical and acute. This expression was first described in 1984 by Bolton et al. in which they described a primarily motor condition, of an axonal, symmetrical and acute nature, in patients hospitalized in the ICU. Such patients had tetraparesis, abolished deep reflexes, as well as difficulty in removing IMV. The main cause related to the episode is the systemic

inflammatory response syndrome (SIRS), mostly triggered by sepsis.⁸ However, Critical Patient's Polyneuropathy is still a condition not completely clarified regarding its pathophysiology and etiopathogenesis. Thus, the aim of the present study is to expose a case of Critical Patient's Polyneuropathy, in order to draw attention to the diagnosis of this condition, which is not uncommon.

II. CASE REPORT

JCD, 63 years old, white, single, obese (BMI > 40), type II diabetic controlled with diet and Metformin 2g / day, mild hypertension, with hyperuricemia (gout). Former smoker and social drinker A clinic of severe abdominal pain, in bar type, appeared on the upper region of the abdomen on 07/07/2018, when he was urgently attended at Hospital Icarai a diagnostic hypothesis of urolithiasis and urinary infection was made. He was medicated with oral antibiotic therapy, analgesics and oriented to outpatient follow-up. He evolved with persistent pain, abdominal stiffness, fever, vomiting and mental confusion. He was admitted on 10/07/2018 to the aforementioned hospital with abdominal septic shock / cholecystitis. He underwent laparoscopy with cholecystectomy on 11/07/2018. A post-surgical coma was induced, it remained so for 58 days. He developed a biliary fistula, requiring laparotomy with placement of drains. The septicemia persisted, a new abdominal approach was performed with washing of the cavity and collection of material for culture. He remained on mechanical ventilation and use of amines for a long time, was tracheostomized and managed to decanulate. During this period, he developed ARDS lung, acute dialysis renal failure (recovered renal function), drug hepatitis and critical patient's polyneuropathy. Discharge from ICU on 28/09/2018. Transferred to the Niterói Hospital Complex on 09/11/2018 where he used Meropenem and Polymyxin B for nine weeks. An echocardiogram showed aortic valve endocarditis. He was discharged from hospital on 03/05/2019 for home treatment (homecare). Hospitalized on 13/11/2019 for surgical exploration of saccular lesion in the left trochanteric region. There was dehiscence of the scar, he

remained hospitalized for 30 days. Presently, he remains in homecare, undergoes daily dressing on the remaining ulcer (sacral) and physical therapy for motor rehabilitation due to the developed neuropathy. He uses Pregabalin 300mg / day since the first hospitalization, Adera D3 7,000UI / alternate days and AAS 100mg / day. He wanders short distances with the aid of canadian crutches and needs assistance for daily activities. The examination reveals tetraparesis with a predominance of the distal brachial and crural thirds; stylo-radial and flexor reflexes of the left hypoactive fingers, patellar hyporeflexia, abolished aquileus; superficial sensitivity: thermal and painful tactile hypoesthesia with paresthesia on the feet soles; profound sensitivity: proprioceptive hypoesthesia and hypopalesthesia in the distal third of the 4 limbs; in addition to flaccid paraparetic gait. Lumbar puncture, ENMG and biopsy of the sural nerve. In the CSF, there was an absence of leukocytes, normal glucose and 20mg / dL proteins. ENMG showed axonal motor sensitive polyneuropathy, with decreased sensory and motor potential amplitudes in the fibular nerves, increased distal latencies and decreased nerve conduction speed in the tested groups of the lower limbs, in addition to positive waves and fibrillations in upper and lower limbs muscles. In the biopsy of the sural nerve, the semi-thin sections included in glutaraldehyde showed axon-myelinic neuropathy in activity without an inflammatory process.



Fig.1: Muscular atrophy with shedding of the feet (distal crural third)

III. DISCUSSION

Critical Patient's Polyneuropathy is a predominantly motor condition, however, related to sensitive, symmetrical and acute impairment associated

with exaggerated systemic inflammatory response syndrome (SIRS), which mostly occurs in cases of sepsis,⁹ during which changes occur in microcirculation, release of inflammatory cytokines and failure in the self-regulation of blood vessels responsible for innervation of peripheral nerves, succeeding in endoneurial edema. Subsequently, there is hypoxia and consequent energy deficits that favor, the primary axonal degeneration of sensory and motor fibers, primarily distal, thanks to the encompassing of axonal transport totally dependent on energy, enabling cytokines and the tumor necrosis factor, to act negatively on the nerve peripheral.⁶ CPP provides prolonged mechanical ventilatory support and difficulty in weaning, in addition to a long hospital stay.^{10,11}

CPP is an acute axonal neuropathy that manifests itself as a consequence of increased survival in patients with multiple organ failure and sepsis. It presents a reversal of the condition, right after the control of the individual's critical condition. The disease manifests itself in a self-limited and monophasic form, with excellent recovery in patients with mild to moderate forms of the disease.¹²

There is widespread asthenia and difficulty in weaning from invasive mechanical ventilation as the two peculiarities sine qua non for the identification of patients with CPP.¹³ Such characteristics happen in a synchronous manner, and are observed regardless of the reestablishment of the level of consciousness and clinical improvement.¹⁴

Critical Patient's Polyneuropathy has several variables with regard to severity and mainly affects the lower limbs, in which the distal region is the most severely affected. Mild sensory disturbances can occur. Occasionally, there are no dysautonomic manifestations. It starts in a subtle way, often only being recognized after adequate control of sepsis complications or multiple organ failure.¹⁵

A study by Garnacho-Montero et al. (2005), demonstrated that CPP has a strong impact on the time of mechanical ventilation, as well as typifying an isolated predictive factor of difficulty in weaning from mechanical ventilation, causing an average of 34 days of stay on IMV and a reintubation percentage of 41%.¹⁶

Another study with a prospective model carried out by De Letter et al. with 98 critically ill patients was evidenced that 33% of them evolved with neuromuscular disorders during their ICU stay. SRIS and the magnitude of the disease were identified as the only independent risk factors observed. Further research has shown that the use of corticosteroids stands out as another risk factor normally seen, being identified as the most relevant

predictive factor for the occurrence of muscle weakness in critically ill patients.¹⁷

Presently, the following are the diagnostic criteria for CPP: (1) immediate generalized asthenia for the establishment of critical illness; (2) diffuse weakness, affecting the proximal and distal muscles, symmetrical, flaccid and which normally preserves cranial nerves; (3) dependence on mechanical ventilatory support; (4) MRC score below 48 points, observed at different times, with an interval of 24 hours; (5) other causes of asthenia excluded.¹⁸

The diagnosis of CPP is by exclusion. It is essential to rule out metabolic, pharmacological and central causes (Central Nervous System) of asthenia, as well as spinal cord injury and intoxications. The gold standard diagnosis of CPP is performed by means of an electroneuromyography exam, which reveals the pattern of axonal polyneuropathy. Electroneuromyography, in turn, is defined as the gold standard exam. Its results reveal potentials of low amplitude motor and sensory actions; conduction velocity and moderately conserved distal latencies; fibrillations and positive waves may occur in needle stimulation.¹⁹

It is essential to rule out the likelihood of spinal cord injury in patients who develop muscle weakness after trauma; application of significant amounts of medication, leading to porphyria, in patients with acute intermittent porphyria; previous history of decompensated muscle, motoneuron or nerve diseases in patients in whom the reason for acute respiratory failure has not been elucidated clinically; patients with metastatic micro abscesses that can lead to peripheral nerve damage. Furthermore, it is important to emphasize that the reason for hospitalization is evident.²⁰

There is no evidence of abnormalities in the cerebrospinal fluid (CSF) examination or it presents with slight changes.^{21,22} Nerve biopsy shows primary axonal degeneration without evidence of an inflammatory process.²³ The disparity in certain conditions between pathological findings and the severity of clinical manifestations speaks in favor of axonopathy. It has a good recovery if the underlying disease is controlled.²⁴

IV. CONCLUSION

Despite its occurrence, elements that would objectively be related to its pathophysiology, as well as the therapeutic ideal for the management of this condition, remain hidden. For this reason, the importance of further studies regarding the risk factors and diagnosis of CPP is

reiterated in order to optimize the identification and control of diseases to affected patients.

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Neuromuscular Scoliosis: A Neurological Point of View

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Keywords— *Scoliosis, Cerebral Palsy, Duchenne Muscular Dystrophy, Spinal Muscular Atrophy, Friedreich's Ataxia, Espinhal, Ataxia de Friedreich*

Abstract — *Objective: make a review of the main neurological diseases associated with neuromuscular scoliosis and perioperative care during scoliosis correction surgeries. Method: Non-systematic review using a Google Scholar platform for articles with the descriptor “neuromuscular scoliosis” in the journal title. Results and Discussion: 46 articles in English and 3 articles in Portuguese were used for this review. Conclusion: Neuromuscular scoliosis has the fastest course of evolution, higher rates of disability and higher rates of complications in corrective surgery when compared to idiopathic scoliosis. The knowledge of neurological diseases more associated with neuromuscular scoliosis helps in its early detection and its long-term monitoring.*

I. INTRODUCTION

We can define scoliosis as a three-dimensional deformity of the spine, including a curvature in the frontal plane greater than 10° (ten degrees). This curvature is assessed by measuring the Cobb's angle.^{1,2}

Cobb's angle was first described by John R. Cobb. It is obtained on panoramic radiographs of the spine and calculated by the angle of intersection between the upper plateau of the upper vertebra and the lower plateau of the lower vertebra of the scoliotic curve (figure 1).³ Scoliosis can be divided into idiopathic (IS), congenital and neuromuscular scoliosis (NMS). Idiopathic scoliosis is subdivided into infantile, juvenile and adolescent forms. IS develops without the presence of a detectable disease as a

cause of progressive spinal curvature.² Several theories try to explain idiopathic scoliosis through genetic factors or even hormonal imbalance, such as changes in melatonin levels.⁴ IS does not usually maintain its progression during adulthood, but it may need surgical correction in order to avoid the appearance of cardiopulmonary dysfunctions or pelvic obliquity with consequent difficulty in maintaining posture.⁵ Congenital scoliosis, on the other hand, is the most frequent form of congenital spinal deformity, overcoming congenital kyphosis or lordosis. It is due to some aggression to the fetus during the embryological development of the spine and is often associated with other malformations, be they cardiac, urinary or gastrointestinal tract.⁶

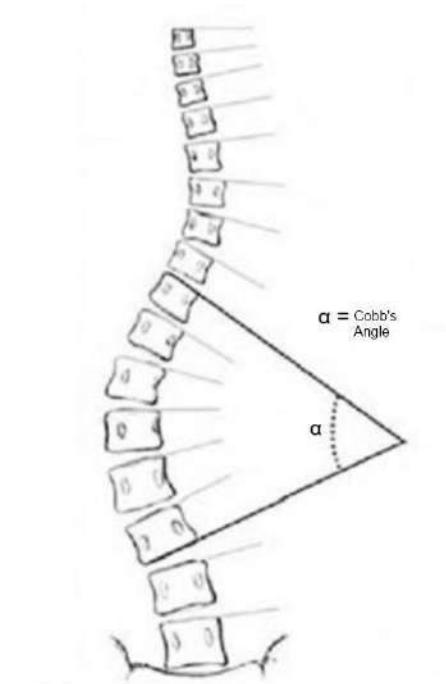


Fig.1: Cobb's angle for scoliosis evaluation.

On the other hand, neuromuscular scoliosis is a scoliotic deformity secondary to muscle imbalance caused by neuropathic or myopathic diseases.⁷ NMS generally has an earlier onset and faster progression when compared to idiopathic scoliosis. It also has higher hospitalization costs, operative complications and number of surgeries for correction.^{8,9} Another difference between idiopathic and neuromuscular scoliosis is the pattern of the scoliosis curve. In IS there is a convex scoliosis curve generally to the right, sometimes with the presence of a double curve whereas in NMS scoliosis is type C with a large single curvature affecting the thoracic and lumbar spine.^{10,11}

The article aims to recognize and discuss the neurological disorders most often associated with NMS. The neurologist is sometimes the first to assess these patients and one of those responsible for their long-term care. Early diagnosis by the neurologist can positively impact the prognosis of individuals with NMS.

II. METHODS AND RESULTS

We performed a non-systematic review of articles through the Google Scholar platform from January 1992 to October 2020. We prefer articles in Portuguese or in English whose title had the descriptor "neuromuscular scoliosis" or "escoliose neuromuscular" in the journal title. We obtained a total of 524 articles from this search. We include experimental, review articles, case reports or expert opinions. Some papers were chosen from the references obtained from the articles of the initial search. Others were

chosen because they address the neurological diseases most often responsible for NMS. We used a total of 49 articles for this manuscript, 46 in English and 3 in Portuguese language.

III. DISCUSSION

Definition and Epidemiology of Neuromuscular Scoliosis

Neuromuscular scoliosis can be defined as a non-congenital spine deformity occurring in individuals with a diagnosis of pre-existing neuromuscular disease.¹² While in neurology the term neuromuscular generally describes only pathologies associated with diseases of the peripheral nervous system with impairment of the muscle or motor neuron, orthopedists use the term for any neurological disease, including cerebral palsy.⁵ We can detect the presence of scoliosis in individuals with neurological disease by performing the Adams test or the anterior tilt test.¹³ The individual bends forward with arms forward, palms facing each other and with feet together. The presence of asymmetries in the tangential visualization of the paravertebral musculature indicates a positive test and the need for radiographic testing to analyze the Cobb's angle.^{13,14}

NMS can occur in up to 90% of children with neuromuscular disease and progress after adulthood regardless of the maturity of the skeletal system, being generally refractory to conservative treatments.¹⁵ The first cases of NMS with surgical correction were described in individuals with poliomyelitis.¹⁶ Currently among the neurological conditions most often triggering NMS are cerebral palsy, Duchenne Muscular Dystrophy, Spinal Muscular Atrophy and Friedreich's ataxia.¹²

Neurological Diseases Most Associated with Neuromuscular Scoliosis

A) Cerebral palsy

Cerebral palsy (CP) can be defined as the presence of motor dysfunction during birth due to an identifiable brain injury during pregnancy. It affects seven out of every 1000 live births in developing countries.¹⁷ It can be subdivided into spastic, choreoatetoid, non-toxic or mixed types. CP is one of the main causes of neuromuscular scoliosis, especially in its quadriplegic spastic form, followed by diplegic and hemiplegic forms.^{18,19} The incidence of NMS in individuals with CP depends on the definition used for scoliosis, but rates between 25 and 69%.^{19,20} Diseases with hypertonia of the trunk muscles such as CP are more often associated with the presence of NMS when compared to muscle diseases that cause hypotonia of the paraspinal muscles.²¹ The risk of developing neuromuscular scoliosis

in individuals with CP increases with age or degree of motor disability due to the classification of gross motor function, being higher in grades IV and V (table 1).²²⁻²⁴

Table 1 - Gross Motor Function Classification System

LEVEL 1	Walks without restrictions, with limitations for more complex motor activities (running, jumping)
LEVEL 2	Walks without assistance, but with limitations in community gait
LEVEL 3	Walks with support, with limitations in the community walk
LEVEL 4	Mobility is limited, requires a wheelchair in the community
LEVEL 5	Severely limited mobility even with the use of assistive technology

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B) Duchenne Muscular Dystrophy

Duchenne muscular dystrophy (DMD) affects two to three boys in 10,000. It is a recessive disease characterized by the presence of a mutation in the dystrophin gene at position 21 of the short arm of the X chromosome. Dystrophin is a protein responsible for maintaining calcium homeostasis.²⁵ Individuals with Duchenne often have progressive scoliosis in the first decade of life. NMS is found in up to 90% of patients with DMD.²⁶ The lordotic posture in patients with Duchenne and the ability to walk can delay the development of scoliosis and corticosteroid therapy can decrease scoliosis rates with the need for surgical correction from 90 to 15% of cases.¹⁶ Deflazacort, an oxazolone derivative of prednisone, had slowed the progression of scoliosis with lower rates of long-term use compared to other corticosteroids.²⁷ There are defending authors of early corrective scoliosis surgery in mild cases to preserve respiratory function, while others perform surgery only in severe cases because not all cases of DMD evolve to severe scoliosis. Furthermore, surgery sometimes does not increase survival despite the positive impact on daily activities.²⁶

C) Spinal Muscular Atrophy

Spinal muscular atrophy (SMA) represents a recessive autonomic genetic disease with muscle atrophy due to degeneration of the motor neurons in the anterior spinal cord and presents in eight out of every 100 thousand live births.²⁸ This degeneration occurs due to deficiency of the neuronal survival protein due to mutations in the SMN 1 gene. There are three types of SMA in childhood (I-III) based on the age of onset and motor development milestones.²⁹ NMS occurs mainly in type II spinal muscular atrophy, with rapid progression associated with pulmonary restriction.¹ Scoliosis rates in AMS are around 80% of cases.¹⁰ Unlike individuals with DMD where ventilatory restriction affects the diaphragm, individuals

with type II SMA have pulmonary restriction due to predominant deformity in the thoracic region, causing the parasol/ umbrella chest phenotype.³⁰ In SMA Type III only occurs NMS later, after loss of ambulation.³¹

D) Friedreich's ataxia

It is the most common form of progressive spinocerebellar degeneration. It corresponds to a recessive genetically transmitted ataxia, caused by repetition of GAA trinucleotides (guanine, adenine, adenine) within the frataxin gene on chromosome 9q13.³²⁻³⁴ The mutation in the frataxin gene causes iron accumulation in the mitochondria, with cell death.³² Clinically, it presents as a progressive cerebellar ataxia beginning at around 25 years of age, associated with peripheral neuropathy and pyramidal symptoms. Other changes can also be found, such as pes cavus, optic atrophy, diabetes and cardiomyopathy.³³ NMS occur in about 60% of patients with Friedreich and in 30% of cases scoliosis is not progressive. The younger the age of onset of symptoms, the more frequent is the presence of scoliosis and this does not depend on gait changes.³³

E) Myelomeningocele

It is the main type of spinal dysraphism and can cause NMS both by injury to the first motor neuron and by injury to the second neuron at the anterior tip of the spinal cord. The cord and nerves protrude through the closed LAMINA in an incomplete way.¹ The prevalence of scoliosis in patients with myelomeningocele is 53%, with a slight predominance in females.³⁵ Complication rates in myelomeningocele surgeries may be more frequent when compared to other causes of neuromuscular scoliosis, highlighting high rates of urinary tract infection.⁸

F) Charcot-Marie-Tooth disease

Also known as hereditary sensory-motor neuropathy, Charcot Marie-Tooth Disease (CMT) is the main hereditary peripheral neuropathy. It can be divided into dominant, recessive and X-linked forms.³⁶ Although it most commonly affects the limbs, especially the lower ones, it is capable of causing NMS in up to a third of cases. CMT is best known for being the leading cause of pes cavus of neurological origin in the general population.^{36,37}

G) Other conditions

Poliomyelitis, although it is the first disease where the issue of scoliosis in neuromuscular diseases has been raised, is currently a condition rarely found due to vaccination.³⁸ Guillain-Barré syndrome has rare reports of scoliosis as a sequel.³⁹ Congenital myopathies, although rare and non-progressive, can also cause scoliosis over the years.⁴⁰

Preoperative Evaluation in Neuromuscular Scoliosis

The main indication for scoliosis surgery is the presence of curvature of the trunk or pelvic obliquity with inability to maintain posture and sitting position.¹² Cobb's angle greater than 40° may also indicate scoliosis with necessity of surgical correction.¹⁸ Pelvic obliquity is defined as the failure of the pelvis to remain perfectly horizontal in the frontal plane. The risks of pelvic obliquity are greater in patients with NMS of spastic origin such as CP when compared to the flaccid forms found in DMD and AMS.¹² Despite the risks of extensive surgery in debilitated individuals, patients undergoing scoliosis correction surgery have improved quality of life, lower pain rates and higher levels of family satisfaction after the procedure.^{18,24,41}

Unlike cases of IS, individuals with NMS may present cardiac involvement due to their neurological condition.^{14,32} Patients with DMD have heart disease in 10 to 20% of cases. Undiagnosed cardiomyopathy in DMD associated with blood loss during scoliosis correction surgery can lead to perioperative cardiac arrest. DMD cardiomyopathy sometimes does not correlate with echocardiographic dysfunction, and a cardiac study by magnetic resonance is suggested.¹⁴ Individuals with Friedreich's Ataxia present with hypertrophic cardiomyopathy with left ventricular dysfunction and this can progress to dilated heart disease, contraindicating scoliosis surgery.³²

Considering patients with CP, it is important in the perioperative period to evaluate the adjustment of medications against spasticity. Drugs such as baclofen can induce seizures during both their introduction and withdrawal.⁴² In addition, there is controversy as to whether individuals with CP can present scoliosis progression with the use of baclofen through an intrathecal pump.⁴³

Postoperative Complications in Neuromuscular Scoliosis

Complication rates in neuromuscular scoliosis surgeries are estimated to range from 18 to 75% in the postoperative period. These complications are classified in different ways. One of these classifications divides complications into intraoperative and early and late postoperative.¹¹

Respiratory disorders are the most frequent postoperative complications in most studies and most observed in individuals with forced vital capacity below 50% in the preoperative period. In these cases, noninvasive ventilation before surgery can decrease postoperative risks, especially when vital capacity is below 40% of predicted values.⁴⁴

Gastrointestinal disorders are attributed to paralytic ileus

by medications such as opioids or during anesthetic procedures, presence of gastroesophageal reflux or in patients with poor nutritional conditions, with high risk of superior mesenteric artery compression syndrome.⁴⁵ In debilitated patients below the fifth weight percentile, nutritional support is recommended weeks to months before surgery.⁹

Infections after the surgical procedure are associated with high or low body mass index, lymphocyte count below 1500 mm³ or serum albumin levels below 3.5 g/dL.⁴⁵ Among the agents most involved in the infection of surgical wounds are *S. Aureus*, *P. aeruginosa* and *E.coli*.⁴⁶ It is important not to confuse fever of infectious origin with fever due to the release of inflammatory cytokines such as IL-6 and TNF- α from the extensive surgical procedure to correct scoliosis. This febrile condition occurs on average up to seven days after the procedure in up to 20% of cases.¹⁵

NMS surgeries show greater volumes of bleeding when compared to individuals with IS and different etiologies of NMS may show different volumes of blood loss. For example, individuals with DMD have higher rates of bleeding compared to individuals with AMS.⁴⁷ This is explained to the absence of dystrophin in the smooth muscle cells of the vessels and the consequent contractile inability to stop the bleeding.²⁵ Individuals with CP and associated epilepsy, on the other hand, may have a greater volume of bleeding due to platelet dysfunction or coagulation factors deficiency from the use of anticonvulsants.⁹ Hypotension during surgery can reduce blood loss, however it can increase the risk of neurological injury. An alternative to a drop in hematocrit may be to transfuse autologous blood taken before the procedure and avoid increased abdominal pressure over the vena cava for long periods in the decubitus position.⁴⁸ It is possible to reduce the risk of complications by performing scoliosis correction surgery in more than one procedure in different days, however at the expense of longer hospitalization. Finally, tranexamic acid, a substance that inhibits fibrinolysis, can be used during scoliosis surgery to decrease bleeding rates.⁴⁷

Intraoperative Monitoring in Neuromuscular Scoliosis Surgery

Neurophysiological monitoring is useful during surgeries to correct idiopathic scoliosis and, despite its high cost, can be compensated by a reduction in neurological sequelae and length of hospital stay. It mainly uses the somatosensory evoked potential (PESS) by measuring the fall in its amplitude or velocity of conduction.⁴⁹ In NMS can be difficult to assess the PESS as dysfunction often affects the underlying nerve conduction as in Friedreich's

ataxia.³² However, some pathologies associated with NMS may present a low risk of injury during scoliosis surgeries regardless of the use of intraoperative monitoring as in cases of CMT.³⁷ Another possibility of operative monitoring in patients with NMS is through motor evoked potential by transcranial electrical stimulation. However, there are risks of inducing seizures in susceptible individuals, such as patients with CP.⁴⁹ The combined use of PESS and transcranial electrical stimulation can increase the reliability of intraoperative neurophysiological monitoring.⁴⁴ The Stagnara test or awakening test can be difficult to perform in individuals with neuromuscular scoliosis and intellectual dysfunction in the absence of intraoperative monitoring.⁴⁵ The test consists of reducing sedation and mobilizing the lower limbs during surgery. Failure to mobilize may indicate neurological injury requiring suspension of the procedure.⁴⁹ Finally, although more frequent compared to IS surgery, the incidence of neurological injuries during NMS surgery is lower than other operative complications.⁸

IV. CONCLUSION

Neuromuscular scoliosis is a clinical condition resulting from several common pathologies in neurological clinical practice. These illnesses can cause scoliosis through different pathophysiological mechanisms. NMS presents faster progression, frequent requirement of surgical correction and high rates of complications in the perioperative period when compared to idiopathic scoliosis. Under the perspective of multidisciplinary health care, scoliosis surgery is performed by the orthopedic surgeon. However, the neurologist usually participates in the assessment regarding the etiological diagnosis of NMS or in the follow-up of these individuals regardless of the indication for surgical correction.

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Cognitive damage after COVID-19 in a patient with Parkinson's disease and dementia: A case report

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Keywords— Cognitive Damage, COVID-19, SARS-CoV-2, Parkinson's disease.

Abstract — *Introduction: The human disease associated with the new coronavirus, called COVID-19, was initially discovered in Wuhan, China. Although the existing literature on cognitive damage resulting from this injury is still very scarce, recent studies have shown dysfunction in the field of sustained attention, memory, verbal fluency and executive function, especially in patients with baseline neurocognitive fragility, such as Parkinson's disease (PD). These tend to have exacerbation of symptoms related to PD, in addition to strong psychological distress. Therefore, the aim of the present study is to report the case of a patient with PD and Dementia who evolved with cognitive decline during SARS-CoV-2 infection. Case Report: We present the case of a 63-year-old male patient with Parkinson's disease and dementia diagnosed 1 year before the condition, who presented significant cognitive decline during the SARS-CoV-2 infection. Discussion: The presentation of COVID-19 reported here consists of an atypical manifestation of the disease in a patient susceptible to cognitive damage due to the underlying dementia. It is believed that this pathology can cause patients with cognitive impairments that last from months to years after the infection, as observed in SARS-CoV and MERS-CoV infections. Conclusion: the effects of SARS-CoV-2 on cognitive function are gradually more apparent. Still, clinical trials in the short, medium and long term are essential to determine the main risk and vulnerability factors associated with cognitive impairment by COVID-19.*

I. INTRODUCTION

The human disease associated with the new coronavirus (SARS-CoV-2), called COVID-19, was initially discovered in Wuhan, China. Such injury spread quickly to different continents, becoming a pandemic¹. Although this pathology leads predominantly to symptoms of the respiratory system, different studies have reported neurological manifestations secondary to this infection, which affect at least 36% of patients, justifying the neurotropic potential of the virus^{1,2}.

Although the existing literature on cognitive impairment from COVID-19 is still very scarce, recent studies show dysfunction in the field of sustained attention, memory, verbal fluency, and executive function³⁻⁵. Since the virus was recently discovered, there are obviously no long-term studies that demonstrate its chronic consequences in individuals who have recovered from the disease. Even so, short and medium term neurological deficits are already observed in surviving patients of COVID-19⁶.

Lesions of the Central Nervous System (CNS) resulting from infection with the new coronavirus are associated with three possible mechanisms: cerebral hypoxia resulting from breathing difficulties, vascular changes resulting from the state of hypercoagulability, or direct attack of the virus on the CNS through direct transport to brain tissue by breaking down the blood-brain barrier or through the mucous membranes of the nasal cavity⁶⁻¹⁰. Each of these factors can trigger brain damage, affecting patients cognitive ability.

The impact of the COVID-19 pandemic on the physical and mental well-being of the world's population is indisputable. However, this repercussion tends to be experienced more intensely in patients with chronic diseases, such as Parkinson's disease (PD)¹¹. Although there are no reports regarding the greater probability of infection in PD patients when compared to the general population, it is known that these, when affected by SARS-CoV2, will experience worsening of their symptoms, especially greater psychological suffering, which in turn this time worsens motor symptoms and neuropsychiatric symptoms, such as: anxiety, lack of concentration, and lower scores on their cognitive skills¹¹. Thus, the objective of the present study is to report the case of a patient with Parkinson's Disease and Dementia who started a cognitive decline during the SARS-CoV-2 infection, and through this, proposes a provocative discussion regarding the main evidence available in the literature regarding cognitive decline and COVID-19.

II. CASE REPORT

FASM, male, white, 63 years old, married, born and resident of the city of Rio de Janeiro. He started to lower his level of consciousness with lethargy and headache, exacerbation of unmotivated laughter, too much anxiety, emotional lability, visuospatial dysfunction, executive dysfunction, constructive dysfunction, dysnomia, in addition to impaired recent and past memory, requiring help for walking and feeding, without any respiratory complaints or signs of infection. Previous history of Parkinson-Dementia complex diagnosed a year ago with significant speech impairment, undergoing multidisciplinary treatment with speech therapists, physiotherapists, psychologist and neurologist. Recent neuropsychological report provided by the psychologist shows that the patient had gradual and sustained improvement in attention, executive function, and episodic memory, up to 15 days before the onset of symptoms. However, after the onset of the condition, he presented a worsening in the performance of tasks and activities, severe attentional difficulty, as well as in the understanding of the commands, functions hitherto performed with some ease. After the patient's cognitive decline, his wife started suffering from the Flu Syndrome and then the suspicion of COVID-19 was started as a triggering factor of the condition now presented by the patient. The PCR performed on 26/10/2020 on the patient's nasal SWAB sample detected genetic material compatible with SARS-CoV-2, and a serology performed on 11/09/2020 revealed IgM and IgG reagents. There was no need for hospitalization or mechanics. Using Prolopa BD 25 mg, Prolopa HBS 200 mg, Alois 10 mg, Brintellix 10 mg, QueraLP 0.375 mg, Cronobê 1 ampoule per month, Proians 1 capsule per month and Extima 1 sachet per month.

III. DISCUSSION

The presentation of COVID-19 reported here consists of an atypical manifestation of the disease in a patient susceptible to cognitive damage due to the underlying dementia. Such presentation is similar to previous reports of COVID-19 in patients with previous dementia. The aspect of SARS-CoV-2 infection in patients with dementia consists of changes in mental status, such as: agitation, confusion, disorientation, hyporexia and refusal of care¹²⁻¹⁴.

Although the existing literature on cognitive damage from SARS-CoV-2 infection is still scarce, much can be learned from similar viral injuries. As observed in infections with other coronaviruses, SARS-CoV and MERS-CoV, it is believed that survivors of COVID-19

can manifest neurological damage from months to years after infection^{15,16}. A study carried out in Chicago, demonstrated that 24% of the participants hospitalized by COVID-19 had short-term memory loss¹⁷. In addition to these, 6 patients from a UK cohort had neurocognitive disorder¹⁸.

A detailed review of the literature revealed a report showing a prevalence of dysexecutive syndrome in 36% of 39 patients with COVID-19 (10). In addition to this, several articles allude to confusion and difficulty in attention in infected patients, which also suggests dysexecutive syndrome^{19,20}. The dysexecutive syndrome is covered by deficits in attention, planning, abstraction, behavioral control and guidance, and is therefore compatible with the case presented here²¹. In both the acute and long-term phases, executive dysfunction can be predicted to be part of the neurological consequences of this viral infection²¹.

More than a third of the participants in an observational study conducted in France showed cognitive impairment after discharge from the Intensive Care Unit (ICU), especially Dysexecutive Syndrome²². In addition to this study, cognitive impairment was also observed in a series of 4 cases, and was manifested as memory deficit and frontal syndrome after discharge from the ICU²³. Although the patient in this report did not need to be admitted to the ICU, symptoms similar to those described above were observed, which corroborates that such conditions do not result only from the treatment conditions of COVID-19, but from the evolution of the disease itself.

Hypoxemia resulting from lung injury caused by SARS-CoV-2 probably contributes indirectly to neuronal injury and underlying cognitive decline⁶. Although patients with COVID-19 pneumonia have relatively well-preserved pulmonary mechanics, they can exhibit severe hypoxemia, and subsequent neurological changes^{6,7}. In addition, the hypercoagulable and hyperinflammatory state observed in COVID-19 contributes to delirium and cognitive decline, given that both inflammation and coagulopathy are independent risk factors for delirium⁶⁻⁸. It is worth noting that the neuroinflammation resulting from the rupture of the blood-brain barrier can facilitate delirium in the short term, in addition to severe cognitive deficits in the long term¹⁰.

Delirium consists of cytokine-mediated activation of microglia and astrocytes, associated with acute brain dysfunction²⁴. It is characterized by hyperactive, hypoactive or mixed states. The hyperactive state is characterized by anxious or agitated behavior with increased psychomotor activity, while the hypoactive state presents as depression or decreased psychomotor

activity^{24,25}. Delirium can trigger fluctuations in attention (focused, sustained or displaced) and awareness (orientation) and can also involve cognitive disorders²⁵.

An Egyptian study carried out in 38 patients with Parkinson's Disease (PD) showed higher levels of stress and lack of concentration during the pandemic in these patients when compared to previously healthy ones, emphasizing that the stress burden related to COVID-19 increased the severity of symptoms in these patients and this effect was mediated by the degree of psychological distress¹¹. Therefore, patients with PD, when affected by SARS-CoV2, experience greater psychological suffering, and worsening of motor and neuropsychiatric symptoms, such as: anxiety, lack of concentration, and lower scores on their cognitive skills¹¹.

The risk factors for a worse prognosis associated with infection by the SARS-CoV-2 virus involve advanced age, the existence of chronic diseases, and smoking²⁶⁻²⁸. Likewise, these factors are associated with an increased risk of cognitive decline²⁹. All of these associated factors correspond to baseline neurocognitive frailty, which increases patients' susceptibility to cognitive complications both during injury and after the hyperinflammatory state³⁰. Thus, the individuals most susceptible to severe infection by COVID-19 also represent the population most susceptible to cognitive decline in the context of COVID-19 inflammation.

IV. CONCLUSION

Although the effects of SARS-CoV-2 on cognitive function are increasingly apparent, neurocognitive syndromes as a consequence of COVID-19 have not yet received adequate attention. However, in view of the above, it is believed that it is highly likely that such injury may manifest itself with deficits in attention, memory and executive function, as well as psychomotor or visuospatial performance. Thus, clinical trials that follow in the short, medium and long term, the cognitive function of patients infected with beta corona virus are essential to determine the main risk and vulnerability factors associated, as well as identify ways to mitigate the potential negative effects in the cognitive functioning of these patients.

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Strategies to improve bioavailability of the existing Drugs for Colorectal Cancer

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Keywords— Colorectal cancer,
Bioavailability, pharmacokinetics,
Antitumor growth, Anticancer treatment,
Drug absorption.

Abstract— Colorectal cancer has many drugs which are available and approved by the FDA with anti-tumorigenesis property and in this study very few drugs are chosen in terms of pharmacological activity and bioavailability of the drugs. Colorectal cancer is cancer that starts in either colon or the rectum. Based on the location from where cancer starts it can either be known as colon cancer or rectal cancer. The colon and rectum are a part of the large intestine and are a part of the human digestive system. Among all the drugs which have been deployed to reduce tumor formation in case of colorectal cancer or to reduce metastasis, show pharmacokinetic and pharmacodynamic properties. The drugs which are less soluble in an aqueous solution even though they have good permeability, dissolution rate becomes the limiting factor for absorption. The saturation solubility could be increased by changing the physical state of the drug along with the addition of co-solvents or it can be improved by reducing the particle size with the increase in surface area. The solid dispersion form of the drug in a dissolved form can improve the efficacy and bioavailability of that particular drug. The drugs available for colorectal cancer patients for enhancing the bioavailability by pharmacokinetic parameter. The existing drugs have some unmet conditions which have reduced clinical efficacy against the anticancer treatment and the limitations and inhibition are pointed out for which a hypothetical theory could be drawn to achieve maximum bioavailability. The lower bioavailability of a drug could be increased by adding another drug or by the method of nano-emulsion and solid dispersion method or by adding natural compounds. Few drugs are not approved yet but have undergone clinical trials, cannot act effectively until and unless they are bound to some other drugs. The combined effect of two drugs can moderate the bioavailability of the drug used before.

I. INTRODUCTION

Colorectal cancer is cancer that starts in either colon or the rectum. Based on the location from where cancer starts it can either be known as colon cancer or rectal cancer. The colon and rectum are a part of the large intestine and are a part of the human digestive system. The colon

consists of four segments: the ascending, transverse, descending, and sigmoid colon. The common symptoms of colorectal cancer are constipation, diarrhea, change in stool color and shape, blood in stool, bleeding from the rectum, excessive gas, and abdominal cramps. In the advanced stages of cancer, the symptoms are excessive

fatigue and weakness, sudden weight loss, vomiting, a feeling that the bowels won't completely empty. If cancer spreads to other parts of the body one can also experience jaundice, difficulty in breathing, bone fractures, blurry visions, headaches. A sub-group of the patients is formed due to a specific hereditary colorectal cancer syndrome known as the 'Lynch syndrome' caused due to the mutation in any one of the DNA mismatch repair genes: MLH1, MSH2, MSH6, PMS2, or EPCAM which results in the accumulation of the mutation. The second most common cancer syndrome is caused due to the mutation in the adenomatous polyposis (APC) gene which regulates the

occurrence of the "Wnt" pathway. The patients develop colorectal adenomas which may lead to the formation of colorectal cancer. Several environmental factors also affect the incidence of colorectal cancer in an individual. Smoking, drinking, and obesity increase the risk for colorectal cancer. Excessive smoking and drinking can increase the risk by about 50%. Intake of too much processed and red meat can increase the risk of cancer whereas intake of milk, fibers, vitamins can decrease the risk of cancer occurrence.

II. LIST OF DRUGS AVAILABLE FOR COLORECTAL CANCER TREATMENT

Drugs available for colon cancer based on the similar model of action we have refined the following drugs:

SL	Name of the drug	Function	Drawback	Reference
1.	*Camptothecin	Effective anti-cancer agent for treating tumor growth in colon cancer by DNA synthesis and cell apoptosis.	Less soluble in an aqueous solution readily becomes inactive form by lactone ring hydrolysis.	https://pubchem.ncbi.nlm.nih.gov/compound/Camptothecine#section=Pharmacology
2.	*5-Fluorouracil	antineoplastic anti-metabolite blocks the enzymatic changes of cytidine to deoxy derivative.	Lower absorption in the GI tract, inhibition by Eniluracil and thus lesser antitumor activity	https://pubchem.ncbi.nlm.nih.gov/compound/5-Fluorouracil
3	Topotecan	Used in metastatic colon cancer, inhibit metastasis of cancer.	Hydrolysis of topotecan lactone in the gut, cyclosporin acts as the inhibitor molecule. Cannot be effective without irinotecan.	Holcombe RF, Kong KM, Wimmer D. Combined topoisomerase I inhibition for the treatment of metastatic colon cancer. <i>Anticancer Drugs</i> . 2004 Jul;15(6):569-74. doi: 10.1097/01.cad.0000132232.28888.21. PMID: 15205598.
4	Capecitabine	An active drug that reduces tumor proliferation.	Not effective, combination with oxaliplatin gives improved efficacy	Koukourakis, Georgios V et al. "Capecitabine for locally advanced and metastatic colorectal cancer: A review." <i>World journal of gastrointestinal oncology</i> vol. 2,8 (2010): 311-21. doi:10.4251/wjgo.v2.i8.311

III. UNMET NEED IN DRUG DEVELOPMENT (Pharmaceutics & Biopharmaceutics)

Few drugs are approved by the Food and Drug Administration for colon and rectal cancer, among which paclitaxel (PTX) together with BEZ235 shows a synergetic inhibition effect on metastatic growth in case of colon cancer. One of the important drugs Camptothecin (CPT), a potential anticancer drug, shows the antitumor effects by

site-specific inhibition of eukaryotic DNA topoisomerase-I (topo-I), enzyme playing major roles in DNA replication, transcription, recombination, and repair. It exerts its cellular toxicity by breaking DNA with a covalently trapped topo-I-DNA cleavable complex. Another drug fluorouracil is been used to treat colorectal cancer in the form of commercial name Adrucil with antineoplastic activity and classified as an antimetabolite. Even though

the drugs are useful for anticancer therapeutic purposes but certain limitations are related to the pharmaceutical approach. The bioavailability of a drug depends upon how they act on the body and their efficacy, a comparatively lower uptake may indicate in lesser efficacy, whereby a relatively high uptake can lead to acute toxicities. In the development phase of a drug formulation, the exclusive bioavailability must be determined to submit a full new drug application to the authorities as well as the degree of exposure varies. Most of the anticancer drugs are absorbed in the epithelial cell linings of the small intestine and due to the large surface area, the drugs are absorbed to a good extent. But as due to the secretion in the gut and small intestine the pH of that varies from low to high. Some drugs show lower bioavailability and it varies with the change in the difference of pH and other physicochemical factors. There are few studies in patients with impaired hepatic function which are significant for characterizing the pharmacokinetics. If safety is concerned then the substantial portion of that particular drug should be eliminated to start with the initial dosage. The drug Camptothecin has lower bioavailability as it is less soluble in an aqueous solution and very fast conversion from the pharmacologically active lactone form to pharmacologically inactive carboxylate form at physiological pH which causes hydrolysis of the lactone ring. On the other hand, 5-fluorouracil (5-FU) is used to give anticancer treatment by suppressing the tumor progression and in that drug, Eniluracil acts as an inhibitor that inhibits the drug and it shows lesser antitumor activity. Eniluracil is a potential inhibitor that catabolizes and inactivates the 5-fluorouracil group. Few drugs are not approved yet but have undergone clinical trials, cannot act effectively until and unless they are bound to some other drugs. The combined effect of two drugs can moderate the bioavailability of the drug used before.

IV. RESEARCH PROBLEM

Among all the drugs which have been deployed to reduce tumor formation in case of colorectal cancer or to reduce metastasis, show pharmacokinetic and pharmacodynamic properties. It has been observed that several drugs are not effective because of less solubility and absorption. So, the focus will remain on the hypothetical mechanism by which the bioavailability of the drug could be increased to become the drug more effective.

Working Hypothesis:

The lower bioavailability of a drug could be increased by adding another drug or by the method of nanoemulsion and solid dispersion method or by adding natural compounds. In the case of Camptothecin, the less

solubility in aqueous solution drives into lower bioavailability and fast conversion into inactivate carboxylate form. This problem can be achieved by the solid dispersion method by solubilizing in a copolymeric solution. On the other hand, the drug used as chemotherapy in colorectal cancer 5-FU can reduce its functionality when eniluracil binds to it. The bioavailability can be increased by removing eniluracil in a good amount. Most anticancer drugs have a highly variable bioavailability, but a narrow therapeutic range. Many studies have been performed to reduce the pharmacokinetic variability

Mechanistic Hypothesis:

The drugs which are less soluble in an aqueous solution even though they have good permeability, dissolution rate becomes the limiting factor for absorption. The saturation solubility could be increased by changing the physical state of the drug along with the addition of co-solvents or it can be improved by reducing the particle size with the increase in surface area. In another case, the solid dispersion form of the drug in a dissolved form can improve the efficacy and bioavailability of that particular drug. The drugs are enlisted above, CPT is one of the major drugs which have been used in the anticancer treatment and to reduce the side effects of that drug bioavailability should be increased in terms of increasing solubility and stability. Solid dispersion of CPT in Solupus copolymer has been made which helps to disperse the drug in the matrix and thus enhancing the solubility of the drug in an aqueous solution. The targeted drug delivery system of the solid dispersion helps to achieve a high concentration which eventually reduces the dose and side effects. Development of the combinational drug therapy can also increase the pharmacokinetics and reduce the absorption of the drug in the human gut which helps to increase the bioavailability. The drug topotecan when used as a single dose it lacks efficacy which can be again increased by adding Irinotecan and thus the inhibition by Elacridar and Cyclosporin could be avoided. Similarly in the case of the drug Capecitabine, when Oxaliplatin is added, bioavailability could be increased when applied intravenously. The preventive use of the skimmed milk could be a helpful approach to reduce the adverse effect of antimetabolite like 5-FU in patients who have undergone cancer chemotherapy. By adding the skimmed milk with the 5-FU, not only results in good clinical benefits but also great bioavailability by increasing absorption in the GI tract. The skimmed milk reacts positively with 5-FU in a higher-order at its absorption by improving the physical condition of the patients. According to another study, an excess amount of Eniluracil can impact the metabolic activation of 5-FU by inhibiting the main target which is

uridine phosphorylase. This inhibitory effect converts 5-FU into 5 fluorouridine and uracil into uridine. Even though eniluracil does not impair orotate phosphoribosyltransferase which is another activating enzyme for 5-FU. An anabolic of eniluracil could be a cause of deactivation of active 5-FU and thus to maximize the antitumor activity of 5-FU, the presence of an excess amount of eniluracil should be avoided to active 5-FU. It is to be mentioned that eniluracil is a major activator of dihydropyrimidine dehydrogenase (DPD) hence it may be administered before 5-FU. Once the eniluracil has been eliminated, new DPD appears shortly and it is very important to engage an adequate amount of eniluracil that will eventually inactive DPD synthesized during the exposure to 5-FU. It is also to be noticed that the formation of the neurotoxic 5-FU catabolites should be prevented in the central nervous system by engaging an ample amount of eniluracil. So, DPD will be inactivated by eniluracil and it can be partially cleared before 5-FU is administered, thus the clinical efficacy will be increased.

V. AIMS & OBJECTIVES

In this study, we aim to find out the drugs available for colorectal cancer patients for enhancing the bioavailability by pharmacokinetic parameter. The existing drugs have some unmet conditions which have reduced clinical efficacy against the anticancer treatment and we need to find those limitations and inhibition for which a hypothetical theory could be drawn to achieve maximum bioavailability. For this purpose, we have studied few research articles to find all the possible methods to achieve the potential clinical efficacy and thus we can brief a hypothetical overview on the principle behind the pharmacokinetic parameter.

VI. PROPOSED METHOD

In 2007 Crowley et al. have studied the method to increase the stability and the solubility of CPT by developing an oral formulation targeted to a colon cancer cell in the intact form which would reduce the side effects. The study showed that a solid dispersion of CPT in a grafted copolymer made up of polyvinyl caprolactam-polyvinyl acetate-polyethylene glycol or namely Soluplus solution was dispersed in a matrix which potentially increasing the solubility of the drug in an aqueous solution. The undue side effects of the drug can be reduced by applying the high concentrated targeted drug delivery system of the solid dispersed drug to the colon. As per the method described by Warner et al. in 1997, a method was obtained to analyze CPT by HPLC methodology. An acidic microenvironment is produced after the release of the drug

and the system is managed in this way that the lactone ring of CPT can be hydrolyzed. At pH of 7.4 in 100 ml of phosphate buffer, the coated capsule having solid dispersion of CPT as bulk is mixed with or without citric acid. The withdrawn sample at regular intervals is replaced with an equal volume of fresh medium followed by the filtration through the 0.45- μ m filter for analysis by the HPLC method.

The MTT test study on Caco-2 cells described by Anderberg et al. in 1993 was used to evaluate the cellular cytotoxicity of CPT in its solid dispersion to assess the antitumor activity of the drug in acidic pH of 6.0 and mildly alkaline pH of 7.4. The principle of the assay states that the enzyme dehydrogenase in the mitochondria of living cells transforms the yellow MTT [3-(4,5-dimethylthiazol-2-yl) 2,5-diphenyltetrazolium bromide] into a blue-purple formazan crystal.

With 5-FU treatment the excess amount of eniluracil should not be present as it is the potent inactivator of DPD and thus it can be administered before 5-FU treatment. It is important to take a limited amount of eniluracil when new DPD are formed after the elimination of eniluracil, which will eventually inactivate any DPD synthesis. As per the studied information from rats, it is observed that eniluracil dose to inactivate DPD is 6-fold higher in the brain than in non-nervous tissues. In urine samples, the limited amount of DPD inhibition could be encountered by determining total alpha-fluoro-beta-alanine. The half-life of eniluracil is 10 minutes in mice and 34 minutes in rats, respectively. Therefore, according to the study by Thomas et al. in 2010, when the rats were pre-treated with eniluracil one hour before receiving 5-FU, only low levels of eniluracil were present by the time 5-FU was administered. The half-life of eniluracil is approximately 3.5 hours in human patients. If excess eniluracil also decreases 5-FU antitumor activity in cancer patients, care must be taken to ensure that the levels of eniluracil are not more than 5-FU when 5-FU is administered. Patients treated in the phase III study received eniluracil 10 mg/m² simultaneously with 5-FU 1 mg/m² every 12 hours. This high ratio of eniluracil to 5-FU can be easily avoided. If 30mg to 40 mg eniluracil were dosed 12-16 hours before 5-FU, it would adequately inactivate DPD in both nervous and non-nervous tissues, and its concentration would be greatly decreased before the administration of 5-FU. This approach should be amenable to the 5-day or weekly eniluracil/5-FU dosing regimens that use 20-30 mg/m² 5-FU. Thus, the antagonism of 5-FU by excess eniluracil would be avoided. 5-FU when treated with skimmed milk according to Ahmed et al., 2008, also increases the bioavailability of the drug and lowers the side effects. The analysis will be followed by HPLC methodology.

VII. RESULTS

The dosage of 5-FU when given via oral administration with skimmed milk, it showed the stabilized weights in cancer patients after chemotherapy. It was hypothesized that oral administration of 5-FU with skimmed milk may improve absorption of 5-FU from the GI tract. 5-FU when given with skimmed is reasonably absorbed from the GI tract. This indicates that skimmed milk has some positive interaction with 5-FU at its absorption. 5-FU has achieved the plasma concentration that reasonably gave clinical benefits to colorectal cancer patients. The weights of patients can be stabilized during study and their physical conditions may also be improved. Oral 5-FU administration with skimmed milk is safe enough and showed no grade 3 toxicity in this study. It can be concluded that 5-FU can safely be given to colorectal cancer patients with skimmed milk on a long-term basis. Skimmed milk protects colorectal cancer patients from life-threatening toxicity such as Septicaemia. On other hand, when an excess amount of eniluracil is avoided in 5-FU then it can increase the bioavailability, and the absorption of the drug can be increased. Oral administration is better preferred rather than the intravenous injection of the drug. And for CPT, the solubility of CPT could be increased almost 40 times in the presence of Soluplus, indicating excellent affinity between CPT and Soluplus to form a molecular dispersion. Soluplus is a polymeric solubilizer with an amphiphilic chemical structure, having a large number of hydroxyl groups which make it a good solubilizer for poorly soluble drugs in aqueous media. So, Soluplus has been found to have a substantial impact on the solubility of CPT. The results suggest that the Eudragit S100 coated capsules containing solid dispersion of CPT and citric acid, on oral ingestion, will disintegrate in the colon where the pH is between 7.0 and 8.0 because Eudragit S100 dissolves at $\text{pH} > 7.0$. On disruption of capsule shell, citric acid present in the capsule would lower the colonic fluid pH to 6.0 where solid dispersion of CPT would dissolve to release CPT in lactone form which would be subsequently available for uptake by tumor cells. Direct targeting of the drug in its absorbable form to the colon would reduce the dose as well as systemic side effects.

VIII. CONCLUSION

The drawbacks present in the drugs available for treating colorectal cancer can be overcome by achieving the unmet conditions of the drugs by some hypothetical strategies. By deploying few methods to increase the clinical efficacy, drugs can be acted efficiently the patients with cancer. The bioavailability of the drugs can be increased by increasing

the solubility and absorption of the drug in the liver and gut. The solid dispersion method is one of the most used techniques in literature to enhance the bioavailability of the drug hence CPT can work efficiently the cancer patients suffering from colorectal cancer. 5-FU can work in an improved manner when skimmed milk is added into and the oral administration is less toxic than intravenous administration. By inhibiting eniluracil, it can be enhanced with increased bioavailability for 5-FU to act. So, the strategies obtained for improving the clinical efficacy and bioavailability by pharmacokinetic parameters would result in a better cure for therapeutics of colorectal cancer.

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Analysis of the response of two varieties of Maize (*Zea Mays L.*) to different dosages of Nitrogen

Análise da resposta de duas variedades do Milho (*Zea Mays L.*) a diferentes dosagens de Nitrogênio

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Keywords— *Productivity, urea, cultivars.*

Palavras-chave— *Produtividade, uréia, cultivares.*

Abstract— *The cultivation of corn is extremely important for the Western region of Bahia in agronomic terms, as an option for crop rotation, for example. However, this culture needs care in its first 45 days, which will be essential for good production. This initial period will be the one that will demand the most attention. Thus, fertilization is an important factor mainly in relation to nitrogen fertilization. In this work it was possible to analyze the response of two varieties of corn to the effect of different nitrogen dosages in the form of urea (0, 80 kg / ha, 100 kg / ha and 120 kg / ha) in order to obtain productivity results. The variables evaluated were the height of the plants, the number of leaves, the diameter of the stems, and the amount of green and dry masses of the plants. As for the observed varieties, V2 (Sygenta) showed higher values in relation to plant heights. As for the doses applied, nitrogen fertilization made with D3 had a negative influence on all variables evaluated, providing a significant decrease in corn productivity.*

Resumo— *A cultura do milho é extremamente importante para a região Oeste da Bahia em termos agrônomicos, como opção para rotação de culturas, por exemplo. Entretanto, essa cultura necessita de cuidados nos seus primeiros 45 dias que vão ser fundamentais para que se tenha uma boa produção. Esse período inicial será o que demandará maior atenção. Dessa forma, a adubação é um fator importante principalmente em relação à adubação nitrogenada. Neste trabalho foi possível analisar a resposta de duas variedades de milho ao efeito de diferentes dosagens de nitrogênio na forma de uréia (0, 80 kg/ha, 100 kg/ha e 120 kg/ha) visando obter resultados de produtividade. As variáveis avaliadas foram às alturas das plantas, a quantidade de folhas, os diâmetros dos colmos, e quantidade de massas verdes e secas das plantas. Quanto às variedades observadas, a V2 (Sygenta) apresentou maiores valores em relação às alturas das plantas. Já*

quanto às doses aplicadas a adubação nitrogenada feita com a D3 influenciou negativamente em todas as variáveis avaliadas, proporcionando decréscimo significativo na produtividade de milho.

I. INTRODUÇÃO

Para a Região Oeste da Bahia, a cultura do milho é extremamente importante em termos agrônômicos, como opção para rotação de culturas. Na safra 2017/18 a área ficou em 150 mil hectares sendo 140 mil hectares sequeiro e 10 mil irrigado (AIBA, 2018).

A cultura do milho é uma das mais relevantes dentro do cenário da produção agropecuária no mundo como principal fonte de energia dentro do processo de nutrição animal. Na Bahia, as lavouras de milho primeira safra são cultivadas pela agricultura familiar e pela agricultura empresarial, sendo destinada à subsistência, manutenção das criações e abastecimento da cadeia granjeira (suínos e aves) de toda a Região Nordeste. O cultivo acontece em todas as regiões produtoras e ocupam 380,3 mil hectares no estado, com a expectativa de produzir 1.879,4 mil toneladas. Com sistema de produção plantio direto. (CONAB, 2018)

As lavouras de milho do Oeste da Bahia representam 31% da área plantada no Estado, mas a produção representa a 77% do que é colhido. A cultura é considerada a 3º maior da região e ocupou nesta safra uma área de 135 mil/ha, com produção de 931,5 mil toneladas e produtividade de 115 sc/ha (AIBA, 2016). Porém, para que a cultura tenha suas exigências nutricionais plenamente atendidas, em virtude da grande extração de nutrientes do solo, a adubação se torna primordial. Neste sentido, o nitrogênio (N) é o nutriente exigido em maior quantidade pela cultura, sendo o que mais frequentemente limita a produtividade de grãos, pois exerce importante função nos processos bioquímicos da planta (FARINELLI & LEMOS, 2012.).

Segundo Yamada (2000), o fertilizante aplicado ao solo é, também, envolvido nas várias reações do N no solo. Por isso, na prática, é muito difícil determinar a quantidade exata de N que o milho necessita para atingir a produção máxima econômica, pois sua disponibilidade no solo é um processo dinâmico e varia com as mudanças no teor de umidade e temperatura do solo, tipo de fertilizante, ocorrência de doenças, pragas e plantas daninhas e práticas de manejo da cultura.

Buscando melhores resultados na resposta da cultura ao nitrogênio, objetivou com esse estudo analisar duas variedades de milho ao efeito de diferentes dosagens de nitrogênio e assim melhorar a qualidade da adubação nitrogenada da cultura visando uma maior produtividade.

II. METODOLOGIA

Caracterização da área de pesquisa

O trabalho foi conduzido no campo experimental da Universidade do Estado da Bahia (UNEB), município de Barreiras, localizado no extremo oeste da Bahia, entre as coordenadas 12° 08' 00" de latitude Sul e 44° 59' 00" de longitude Oeste com altitude de 452m.

Tendo como base a classificação de Koppen, o clima da região caracteriza-se como sendo do tipo Aw, ou seja, tropical sub úmido com período chuvoso que vão de outubro a abril e período seco que vão de maio a setembro. Segundo o Plano Setorial de Abastecimento de Água e Esgotamento Sanitário de Barreiras (2011), a precipitação média anual na região é de 900 mm a 1.500 mm, sendo que na sede municipal verifica-se uma média anual de 1.122 mm e a média anual de evapotranspiração é de 1.341,2 mm, segundo o método da FAO, e de 1.673,0 mm, segundo os valores encontrados por Bastos et al. (2010) no estudo Potencial Evapotranspiration and Irrigation Requirements for Northeast Brazil, para a cidade de Barreiras. O período chuvoso ocorre entre outubro a abril e período seco entre maio a setembro (OMETO, 1981).

Instalação do experimento

Na área onde foi conduzido o experimento com a cultura do milho coletou-se uma amostra de solo para análise. O mesmo foi caracterizado como sendo do tipo arenoso, com teores de granulometria de 52,36; 22,31 e 25,33 % de areia, silte e argila, respectivamente. Em relação às análises químicas resultaram em: pH=6,5; P=7,06 mg dm⁻³ (Mehlich⁻¹), K⁺=0,535 cmolc dm⁻³; Ca⁺²=3,84 cmolc dm⁻³; Mg⁺²=1,29 cmolc dm⁻³; Al⁺³=0,0 cmolc dm⁻³; V%=81,47; CTC=6,95 cmolc dm⁻³; MO=2,32 gdm⁻³.

O ensaio foi composto por 4 tratamentos, em um arranjo fatorial de (4x4), com 4 doses de adubação nitrogenada a base de ureia (45% de N): 0 (testemunha-T1) 80 (T2); 100 (T3) e 120 (T4) Kg/ha, totalizando um delineamento experimental de blocos completamente casualizados, com duas repetições. A dimensão da área experimental foi de 12 m x 12 m (144,0 m²) com área útil de 10 m x 10 m (100 m²), num espaçamento de 0,5 m x 0,5 m, totalizando 576 plantas. Foram utilizados duas variedades híbridas, sendo a variedade A (AG 8011 - Agrocere) e B (Feroz Viptera 3- Syngenta), a semeadura direta foi realizada manualmente com auxílio de uma

enxada, rastelo, trena, barbante e estacas. Após a abertura do sulco foram semeadas 3 sementes por sulco num espaçamento de 0,5 m entre linhas com utilização da palhada pra evitar o salpicamento de partículas de solo e evitar a evapotranspiração, conservando assim a umidade. Em seguida a área foi irrigada por aspersão, com uma lâmina de água de aproximadamente 7 l/m² ou 200 m³/m para promover a germinação das sementes. As plântulas emergiram cinco dias após a semeadura. A adubação consistiu de 0 g de N em T0; 138,88 g de N em T1; 173,61 de N em T2 e 208,33 g de N em T3 distribuída na linha da semeadura.

Variáveis avaliadas

Determinaram-se as alturas de plantas medindo-se a inserção da última folha aberta de cada uma das plantas. Para os diâmetros dos colmos das plantas foi utilizado um paquímetro digital. No caso da avaliação da massa verde e a massa seca coletou-se doze plantas ao acaso e pesou-as em conjunto para cada parcela utilizando uma balança do tipo comercial.

Análise estatística

Os dados obtidos foram submetidos à análise de variância, em que, para os fatores de natureza quantitativa, realizou-se a análise de regressão e, para as características de caráter qualitativo, foi realizado o teste de Tuckey ($p < 0,05$), com o auxílio do sistema computacional SISVAR.

III. RESULTADOS E DISCUSSÕES

Variedades de milho versus altura de plantas e números de folhas

Na tabela 1 e ressaltado no gráfico 1, observa-se que houve diferença significativa entre as variedades V1 e V2 utilizadas. Sendo a Syngenta a que obteve maiores valores em relação às alturas de plantas (84,86 cm). Contrariando, assim, o trabalho realizado por Oliveira (1989), no qual foi constatado que cultivares mais tardios apresentam maiores alturas de plantas se comparados àqueles cultivares mais precoces.

Já para a variável números de folhas não foi observado efeito significativo das variedades estudadas.

Tabela 1. Determinação das variedades de milho estudadas em relação às alturas e os números de folhas das plantas

Variedades	Altura de Planta	Números de Folhas
	----cm----	
V1	78,47 b	8,01 a
V2	84,86 a	9,60 a
DMS	2,94	1,55

Médias com letras iguais não diferem entre si pelo teste de Tukey a 5% de probabilidade. DMS = diferença mínima significativa. \pm erro padrão da média.

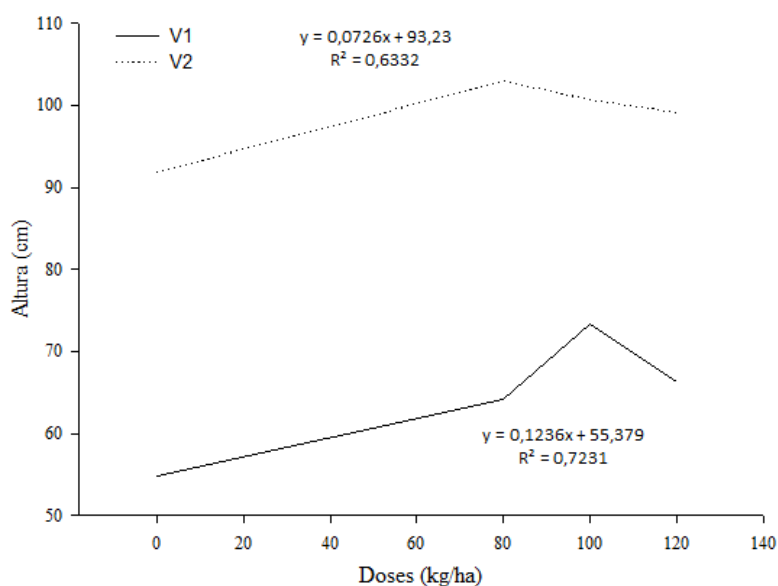


Gráfico 1. Interação entre as diferentes dosagens de nitrogênio e as duas variedades de milho

FONTE: CRUZ (2020)

Dosagens versus altura das plantas e diâmetro do colmo

Na tabela 2, encontram-se as dosagens utilizadas no experimento, às alturas médias das plantas e os diâmetros dos colmos correspondentes a cada dose. Para a variável altura de planta, pôde-se observar que as dosagens D0, D1 e D2 foram estatisticamente semelhantes, ou seja, não houve diferença estatística entre as mesmas. Já em comparação a D3 constatou-se que as plantas apresentaram menores crescimentos com a utilização da dosagem

Tabela 2. Determinação das dosagens de nitrogênio em relação às variedades V1 e V2 quanto à altura das plantas e diâmetro do caule

Doses	Altura de Planta	Diâmetro do colmo
	----cm----	----cm----
D0	86,29 a	7,78 c
D1	96,29 a	9,34 b
D2	100,21 a	11,23 a
D3	65,23 b	5,02 d
DMS	5,45	3,45

Médias com letras iguais não diferem entre si pelo teste de Tukey a 5% de probabilidade. DMS = diferença mínima significativa. \pm erro padrão da média.

De acordo com Rajet al. (1996), para que não haja o comprometimento no desenvolvimento da planta, os níveis adequados de nitrogênio a serem aplicados situa-se na faixa de 27,5 g/kg a 32,5 g/kg. O aproveitamento pelo milho do N de fertilizantes minerais decresce a medida que aumenta a dose aplicada, em vista de o suprimento exceder as necessidades da cultura e possíveis perdas de N, principalmente por lixiviação, volatilização e desnitrificação (DUETE et al., 2008).

Partindo do princípio da dosagem de máxima eficiência física para as variáveis de altura (Tabela 3), percebe-se que para o tipo de solo avaliado, a mesma encontra-se na faixa de 120 kg/ha de N para uma altura máxima de 100,21 cm quando comparada a altura aos 30 dias. As altas temperaturas, comum na região de estudo (Cerrado), fez com que a liberação gradativa do N pela ureia fosse afetada negativamente assim havendo perdas

máxima adotada.

Para a variável diâmetro do colmo, houve diferença estatística entre as dosagens estudadas. Dentre os componentes morfológicos considera-se que, normalmente, a altura de plantas não possui uma correlação com a produtividade. Já para o diâmetro do colmo apresenta correlação com a produtividade por tratar-se de um órgão de reserva da planta (CRUZ, 2006).

na oferta do nutriente (ROCHA, 2019).

Para Silva et al. (2003) até determinadas doses de nitrogênio, a planta continua a crescer; depois que tais doses são atingidas o sombreamento mútuo entre plantas, deve contribuir para a redução do crescimento. O que foi constatado nesse trabalho onde doses iguais a 120 kg/ha fez com que houvesse uma redução nas alturas das plantas assim como nos diâmetros dos colmos.

Dosagens versus número de folhas das plantas

Na tabela 3, fica mais evidente a correlação entre a dosagem máxima estudada e a quantidade refletida nos números de folhas das plantas de milho. A D3 apresentou maiores quantidades de folhas em relação aos demais tratamentos o que ocasionou um auto-sombreamento das plantas fazendo com que houvesse um baixo aproveitamento nessa parcela.

Tabela 3. Determinação dos números de folhas das plantas de milho em relação às dosagens de nitrogênio aplicadas

Doses	Número de Folhas
D0	7,87 b
D1	8,03 b
D2	8,64 b
D3	10,52 a
DMS	2,94

Médias com letras iguais não diferem entre si pelo teste de Tukey a 5% de probabilidade. DMS = diferença mínima significativa. \pm erro padrão da média.

Dosagens versus matéria verde e matéria seca das plantas

Entre os tratamentos D0, D1, D2 não foi

evidenciado diferença estatística entre as quantidades de massas verdes e massas secas pesadas. Já a D3 apresentou menores valores se comparados aos demais (Tabela 4).

Tabela 4. Determinação da massa verde e da massa seca das plantas de milho em relação às dosagens de nitrogênio aplicadas

Doses	Massa verde	Massa seca
	---kg---	---kg---
D0	5,21 a	3,65 a
D1	5,03 a	3,32 a
D2	5,93 a	3,86 a
D3	2,98 b	0,97 b
DMS	3,90	3,45

Médias com letras iguais não diferem entre si pelo teste de Tukey a 5% de probabilidade. DMS = diferença mínima significativa. ± erro padrão da média.

Casagrande & Fornasieri (2002), os quais, avaliando dois híbridos de milho em cultivo de safrinha, observaram efeito significativo entre as diferentes doses de adubação nitrogenada.

De acordo com Vieira & Teixeira (2008), a liberação de nutrientes dos adubos recobertos ou encapsulados depende dos fatores: temperatura e umidade do solo, pois estes adubos consistem em compostos solúveis, envoltos por uma resina permeável à água, que irá regular o processo de fornecimento dos nutrientes.

IV. CONCLUSÕES

A V2 apresentou maiores valores de alturas das plantas em relação à V1.

Quanto às dosagens utilizadas, a D0, D1 e D2 foram estatisticamente semelhantes em relação às variáveis avaliadas, ou seja, não houve diferença estatística entre as mesmas. Já em comparação a D3 a mesma influenciou negativamente em todas as variáveis avaliadas, proporcionando decréscimo significativo na produtividade de milho.

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Continuous Visual Survey on Highway Br-010: Case Study on the Stretch between Estreito and Porto Franco – Ma.

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Keywords— Pavement Defects, Pavement
Evaluation Method, Surface Evaluation,
Results.

Abstract— Over the past decades, Brazil has exhibited economic growth in several sectors. This growth raises important questions about the quality and performance that Brazilian transportation offers the population. The road modal is the most used for transportation of cargo and people in the country. Due to the great demand of this modal, the quality of the highways is affected and end up presenting defects in the sidewalk, signaling, geometry, among others. In this context, the study aimed to evaluate the surface quality of the sidewalk of BR 010, in the stretch between the cities of Estreito - MA and Porto Franco - MA. The study was based on the application of the Continuous Visual Surveys (CVS) methodology, presented in the DNIT Procedure PRO 008/2003, which aims at identifying and quantifying the defects present on the sidewalk surface. Through the results obtained it was possible to identify that the most pertinent pathology throughout the stretch was isolated cracks found in 85.2% of the segments. On the other hand, the least present pathology was slipping, found in only 40.70% of the analyzed segments. Based on the calculations of the Surface Condition Index (SSI), it was possible to classify the stretch according to the quality of the sidewalk surface. 37% of the stretch is in good condition, 51.90% is considered regular, 7.40% is bad and 3.70% is considered to be in very bad condition. From the results obtained in the evaluation it is possible to have a basis to assist in decision making for interventions or reconstruction of critical stretches.

I. INTRODUCTION

In Brazil, one of the first records of road construction occurred in the year 1560, located in the state of São Paulo it was called Estrada do Mar at the time, it connected São Vicente to the Piratininga Plateau and was used to drain the colony's production of wood. "In 1913 it became the first highway in Latin America to receive concrete paving," according to Bernucci et al., (2008, p.16).

Since that time, the displacement through highways is the most used in Brazil, this mode of transport is responsible for making goods and people move in an agile way, this due to the flexibility that the system offers to the

user, facilitating access to boarding and alighting and door-to-door services (CNT, 2019). This availability generates comfort and convenience for users.

The National Confederation of Transport (CNT, 2019), also emphasizes that for the feasibility of the operation of the modality, the road infrastructure in Brazil is considered scarce, insufficient and of poor quality, this due to the low quality of the sidewalk and the lack of preventive maintenance in the country's road network.

Therefore, it is necessary to understand the sidewalk as a structure composed of layers, and like any other structure the sidewalk has a useful life, and the processes of

degradation, deterioration and emergence of pathologies begin as the use of the road begins. In some roads this process comes from exposure to bad weather resulting from the actions of time, and in others due to the application of excessive load on the sidewalk, resulting from overloads carried by large vehicles, according to (BERNUCCI et al., 2008).

The numerous ways of ascertaining the qualities of a road sidewalk allow information to be obtained that can be used to identify and diagnose defects in the sidewalk structure, aiming at determining possible forms of containment and prevention of defects.

The evaluation methods can be considered destructive, semi-destructive and non-destructive. The present study carried out the survey according to the technical procedure methodology of PRO-008 (DNIT, 2003), which uses the Continuous Visual Survey - CVS to obtain data and information. The sidewalk will be evaluated in a superficial way, avoiding the removal of samples, i.e., it does not damage the sidewalk surface.

Surface defects can occur due to resistance, plastic deformations, thermal shrinkage, hydraulic shrinkage, fatigue, functional ruptures and the development of cracks. According to the Highway Conservation Manual (DNIT, 2005), the Highway Operation Program (PER) has groups of services that intervene in the sidewalk infrastructure, in order to contain and prevent the emergence of defects, such as conservation, recovery, improvement and maintenance of roads.

The objective of this study was to identify and evaluate the possible causes of the pathologies found on the Bernardo Sayão Highway (BR - 010) in the stretch between the cities of Estreito and Porto Franco in the state of Maranhão, using the continuous visual survey method.

II. METHODOLOGY

This chapter presents the road selected for the study and its characteristics. The methodology used in the survey is also described.

2.1 LOCATION OF THE SURVEY

The study was based on a case study, where a continuous visual survey (CVS) of the pathologies found on BR - 010 was conducted on the stretch between the cities of Estreito and Porto Franco in the state of Maranhão. The stretch has a total length of 27.9 km and is located 124 km from the city of Araguaína in the state of Tocantins and 125 km from the city of Imperatriz in the state of Maranhão.

The stretch contemplated in the evaluation has great influence on the transportation of grains, cellulose, ore and fuel due to the location of one of the multimodal yards of the North-South Railroad (FNS), which has road access through the coinciding stretch between BR-010 and BR-226, near kilometer 1,244 of Belém-Brasília highway, with facilities of companies such as Cargill S/A, Ceval S/A, ABC Inco, Multigrain and Ceagro. The stretch makes it possible to integrate road, rail and waterway modes, thus allowing goods to be transported to the Port of Itaqui, located in the city of São Luís, capital of the state of Maranhão.

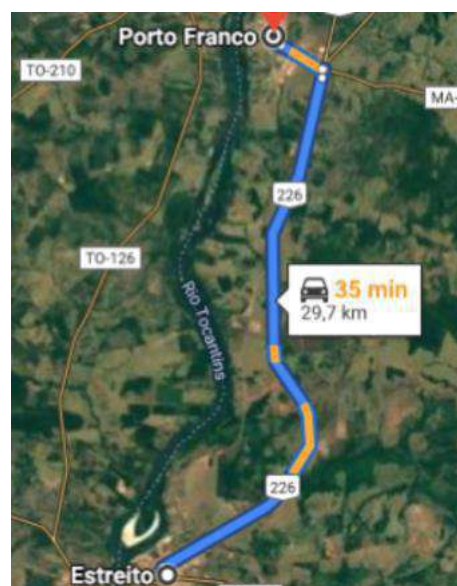


Fig. 1- Route between the two cities

Source: Google Earth, 2020.

2.2 FUNCTIONAL EVALUATION

Among the various methodologies recommended by DNIT for sidewalk surface evaluation, the one chosen for the survey was the Continuous Visual Survey (CVS) according to procedures established in standard PRO 008 (DNIT, 2003). The application of LVC is justified by the fact that it is a simple and economical method, and it is efficient for a quick and non-destructive evaluation of the sidewalk surface.

The field survey was performed in accordance with the specifications of DNIT 008/2003 - PRO, as mentioned in the bibliographic references and methodology. After the survey was completed and with the information obtained from the survey, calculations were made to present the condition of the road network between the cities of Estreito and Porto Franco - MA

For this purpose the LVC was performed in the predetermined stretch with favorable weather conditions

for viewing the defects, where in a vehicle were the driver and two passengers who had knowledge of the purpose and who were responsible for the identification, quantification, frequency and filling out the form, where all defects found were specified. The vehicle was being operated at an average speed of approximately 40 km/h, traveling along the highway in one direction only, since it is a single lane road. The survey procedure was performed by fractioning segments of 1 km in length, thus ensuring the homogeneity of the defects along the entire length of the stretch. The information was collected at the end of each kilometer traveled. With the data it was possible to classify the sidewalk based on three indexes that were calculated and used to help make decisions about possible interventions to be made, namely the Index of Consolidation of Flexible Pavements (ICPF), the Expedited Global Gravity Index (IGGE) and the Surface Condition Index (IES).

- ICPF - The calculation was estimated based on the sidewalk's visual evaluation, classifying the segment's surface according to the concepts excellent, good, fair, poor and very poor, considering the applicability of maintenance measures determined by the professional evaluator.

- IGGE - This index is calculated by taking the average of the data contained in the field survey form, where the results served as the basis for determining the IES, using the following formula:

$$IGGE = (Pt \times Ft) + (Poap \times Foap) + (Ppr \times Fpr)$$

Where:

- Pt = Weight of the crack set;
- Ft = Frequency of the crack set;
- Poap = Weight of the deformation set;
- Foap = Frequency of the deformation set;
- Ppr = Weight of the set of pans and patches;

- Fpr = Frequency (quantity per km) of the set of pans and patches.

- IES - This is the index whose values are between 0 and 10, and is evaluated according to ICPF and IGGE calculations. It is used as a basis for determining the concepts of excellent, good, regular, poor, and very poor.

The DNIT 008/2003 standard has three forms attached to assist in the development and conclusion of the Continuous Visual Survey results. The first form is in Annex "B" of the standard, which was used in the field to fill in the frequencies of defects and road data. The third form is in annex "C", and was used after the data survey to calculate the IGGE of each segment. The third form is in annex "D", and it is where the ICPF and IGGE data developed in the forms mentioned above are contained. From the determination of these data, the IES value was established, which is the index responsible for determining the legitimate state of the evaluated road.

III. RESULTS OF THE DISCUSSION

To perform the procedure the team was composed of a driver, and two technicians, one of them being the Civil Engineer Iza Eduarda Oliveira Vargas enrolled in CREA TO - No. 241604372-2, both assessed the segments reporting relevant points, identifying and quantifying the pathologies found along the road, thus totaling the 27.9 km distance between the cities.

A total of 28 segments were analyzed along the entire stretch, Table 01 specifies the defects according to the quantities found in each section evaluated, and also the frequency of defects in the network in percentages according to the severity levels that vary between low, medium and high.

Table.1: Sections with defects according to the degree of severity.

DEFEITOS	NÍVEL DE GRAVIDADE				TOTAL DE SEÇÕES COM DEFEITOS	FREQUÊNCIA DOS DEFEITOS NA MALHA AVALIADA (%)
	NÃO POSSUI DEFEITOS	BAIXO	MÉDIO	ALTO		
Panelas	7	6	2	12	20	74
TR	4	6	3	14	23	85,2
TJ	6	6	1	14	21	77,77
TB	6	6	1	14	21	77,77
Remendos	7	2	0	18	20	74
Afundamentos	14	1	4	8	13	48,14

Ondulações	10	1	4	12	17	62,1
Desgastes	4	1	5	17	23	85,2
Exsudação	13	1	4	9	14	51,9
Escorregamento	15	0	3	8	11	40,74

tr = trinca isolada, tj= trinca couro de jacaré, tb = trinca em bloco.

Source: Prepared by Brito (2021).

From this it was possible to note that the most relevant defects found were the TR (isolated cracks) present in 85.2% of the track and found in 23 of the 27 segments analyzed, this type of crack can be subdivided into transverse, longitudinal and shrinkage cracks. The main factor influencing the emergence of this pathology is temperature. In the same proportion, wear and tear was found in 85.2% of the road; this type of pathology is associated with the high traffic flow of heavy vehicles in the region.

The interconnected cracks were the second most relevant defect present in 77.77% of the track, these pathologies were observed in 21 of the 27 segments analyzed, this type of cracks is subdivided into two types. The first type is the TJ (alligator skin cracking) whose appearance is related to sidewalk degradation due to repeated traffic loads. The second type is TB (block cracking), which, according to Silva (2008), is related to shrinkage of the asphalt coating and temperature variation during the day.

The third most frequent defect was undulation, present in 62.1% of the road, observed in 17 of the 27 segments analyzed. These types of pathology result from the low stability of the asphalt mix.

The patches and potholes were found in the same proportion, being observed in 74% of the road, both defects were noted in 20 of the 27 analyzed sections. Potholes are defects derived from other defects and patches are also corrections of other defects.

Ripples were found in 17 of the 27 segments, this demonstrates that this type of defect is present in 62.1% of the evaluated stretch. According to CNT (2017), the main causes of this type of pathology are the lack of stability of the asphalt mixture, excessive moisture of the subgrade soil, and lack of aeration of the liquid asphalt mixtures.

The least frequent defects found in the evaluated segments were exudation, which was observed in 14 of the 27 segments and occurs due to excessive exposure of the sidewalk to heat. Sags, which are present in 48.14% of the road, can be classified as plastic when the sidewalk has elevations along its length and can also be classified as consolidation. And the least frequent was the slipping

observed in only 11 of the 27 segments analyzed, present in only 40.74% of the road, this type of pathology is caused due to slipping of the asphalt mass that due to excess binder used

Figure 02 shows the graph that presents the results of the evaluation made by the technicians of the quality of the segments of the evaluated stretch, where they classified the sidewalk as good, fair, poor and very poor, according to the IES results.

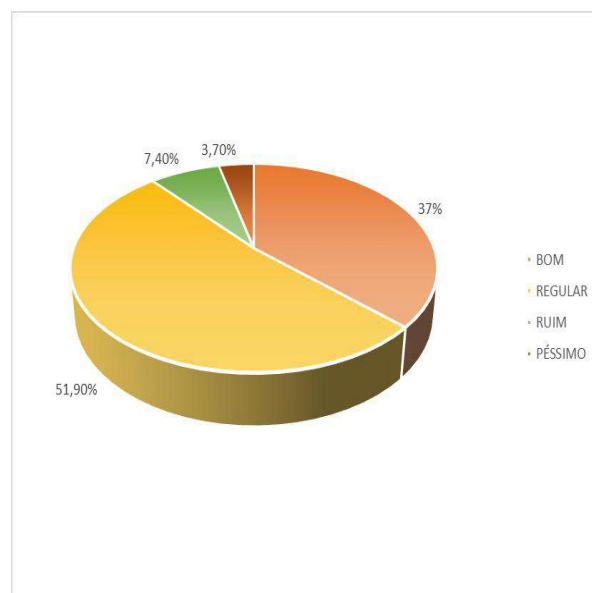


Fig. 2: Quality chart of the stretches

Source: Prepared by Brito (2021).

Figure 02 illustrates the results of the technicians' assessment of the sidewalk surface quality. Based on the application of the concepts presented in the graph, it was possible to establish the necessary corrective measures for each stretch. For the optimal concept, the DNIT (2003) standard suggests that only routine maintenance be done; on the analyzed road no section was found where this concept is applied.

In the graph it is possible to see that 37% of the analyzed stretch presents the good concept according to the application of the ICPF concept. The good concept

encompasses defects such as wear and tear, cracks that are not too serious in not very extensive areas.

The next concept is regular, present in 51.70% of the stretch. In this concept are defects such as potholes and patches.

The bad concept is present in 7.70% of the stretch, which includes defects such as surface or deep patches, in which case solutions such as resurfacing with previous corrections are indicated.

And finally, the application of the very poor concept occurred in only 3.70% of the stretch. This type of concept includes widespread defects and degradation of the coating and other layers; reconstruction of the stretch is suggested.

IV. CONCLUSION

The Continuous Visual Survey (CVS) methodology used for the survey and as a basis for the calculations succinctly met the needs of a surface survey that did not damage the sidewalk surface. Although this type of survey meets this need, it lacks important information and data such as rutting, which is permanent rutting caused by plastic and structural deformation.

However, the data made available by the survey made it possible to verify that the most relevant pathology on the sidewalk surface on the stretch between the cities of Estreito and Porto Franco - MA was isolated cracking. Afterwards it was also possible to identify that 51.90% of the stretch analyzed is in a regular situation and only 3.70% is in a terrible situation.

These results can serve as a basis to help make possible decisions to improve or recover the sidewalk surface. Furthermore, this type of survey is important because it contributes to mapping the pathologies present on the road.

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Social Violence and School Dropout

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Keywords— Education, School, Escape,
Society, Violence.

Abstract— Understanding the concept of violence, in its most diverse and comprehensive forms (physical, verbal, moral, sexual, symbolic, structural, etc.) and deepening the debate on the issue of school failure, especially on the most perverse form of failure, which according to scholars is evasion, since it removes the breast of the school any and all opportunities for socio-educational reparation, is what is brought up in this work. The results obtained through the applied questionnaires show us that the picture is quite worrying and demonstrate that there is still a lot to be done. However, only by knowing closely the paths that permeate violence and school dropout, even knowing that there is no panacea for this evil, without the construction of an effective and permanent public policy for and in education, can such scenarios be reversed.

I. INTRODUCTION

As for the discussion of violence and school dropout, it is necessary to know its true causes, because it is only through a deep investigative process that one can understand and seek to solve such problems.

Where they arise, who cause them, what are the consequences and losses that these actions will bring in the medium and long term for Brazilian and global society, since the world is going through an intense process of globalization, will be the objectives of this work. Theoretically based on Durkheim's thought and on the studies of the main contemporary critics and conceptualizers on the subject; above all from Brazilian studies that address the issue of evasion, exclusion and school violence in the daily life of Brazilian public schools.

It is not uncommon for news reports, magazines, newspapers and specific literature to address the subject of

failure and social violence. Violence that can be physical, verbal or moral and has amazing results in the evaluations of educational institutions. A recent survey by the University of Brasília - UNB demonstrates the growth of violence in schools across the country. More than half of public schools have already been victims of depredation. Thefts, thefts, physical, moral or verbal attacks have affected teachers, staff and students.

Studies carried out by UNESCO, since 1997, show that approximately three thousand Brazilians, aged between 15 and 29 years, died victims of violence in schools and that, among five thousand young people, 60% reveal that they have already suffered at least one aggression.

Another factor to be analyzed is to know to what extent the issue of failure and violence affects the social and cognitive development of the student. It is known that this can generate ills and traumas that leave irreversible sequels in the short, medium and long term.

It is not just today that violence has been a constant reality that integrates the daily life of Brazilians. What is aggravating now is its high degree of occurrence in the public school environment.

Violence is like a disease. It has its causes that must be thoroughly examined.

In illness it is not enough to take care of the symptom. It is necessary to know its causes and apply the appropriate remedy. Violence at school is also a symptom that, in order to be solved, will have to start with the diagnosis of its causes, not only the immediate ones, but also the profound ones.

In Brazil, the educational context does not harmonize knowledge with skill and attitude, that is, it does not integrate Knowledge, with Know-How and Want-to-Do respectively. This last requirement, focused on attitude, is intrinsically linked to social factors that are, at times, neglected and not always taken into account by the official and private educational system.

II. METHODOLOGY

The methodological process adopted in this research was carried out through a qualitative and quantitative study.

In the qualitative research work, the analysis was sought in books, scientific articles, electronic publications, etc. We tried to show the need to study the relationship between school dropout and social violence. It also analyzes its impacts on the formation of society, which, in theory, sees education as an important social bias in the formation of citizens.

With regard to quantitative research, Dencker (1998, p. 124) reveals that: exploratory research seeks to improve ideas or discover intuitions. It is characterized by having a flexible planning involving, in general, bibliographic survey, interviews with experienced people and analysis of similar examples.

As for practical investigation, it is essential to make use of a research technique through the application of questionnaires, which according to Dencker (1998, p. 89) in the questionnaire, the questions are delivered in writing and the informants fill in the answers, where the questionnaire will be characterized. data collection.

This research was applied in the five largest public schools in Feira Nova, which involves a number of approximately three thousand and eight hundred students, a total of 85 teachers, five assistant principals / directors and eight pedagogical coordinators. It had eight questions between open and closed.

Once the questionnaire was answered, an analysis was made of the data obtained, through statistical treatment, from which the answers to the possible causes of social violence and school dropout came out, if there is any relationship between them and if there is, to what extent this relationship has contributed to the occurrence in greater incidence of these social phenomena.

III. THINKING ABOUT VIOLENCE

3.1. Conceptualizing Violence

There is a record that violence has accompanied man since the beginning of human history. Note that in the Bible, in its first Book, that of Genesis, in the first chapters, violent acts are already reported, as is the case of homicide involving the brothers Cain and Abel. The children of Jacob, out of envy, beat and sold their younger brother, Joseph. In the New Testament quotations, the Romans, with their domination over Israel, practiced a multitude of violent acts, such as the stoning of Stephen and Jerusalem one of the best known cases for humanity culminated in a series of cruelties of which Jesus Christ was a victim. The most diverse forms of violence, such as: hangings in a public square; men who fought to the death in the coliseums to delight the audience; the Holy Inquisition that victimized countless people, Nazism and excessive wars populate the history of mankind.

Several thinkers and writers have tried to explain the causes of this phenomenon. According to Freud (1993), man already appears with an innate predisposition to violence, he is born and grows in a violent environment, because society is also violent, while other authors say that no one is born violent. Becomes.

In the view of some thinkers, violence can be divided into structural and systemic. According to Minayo (1994), structural violence "is characterized by the prominence in the performance of economically or politically dominant classes, groups or nations, which use laws and institutions to maintain their privileged situation, as if this were a natural right", while "systemic violence arises from an authoritarian practice, deeply ingrained", despite the democratic guarantees that are expressed in the 1988 Constitution.

Chauí (1999), when formulating his concept of violence, uses four different parameters. The structure is distributed as follows:

1) everything that acts using force to go against the nature of some being (is to denature); 2) any act of force against someone's spontaneity, will and freedom

(it is to coerce, embarrass, torture, brutalize); 3) any act of violation of the nature of someone or something positively valued by a society (is to violate); 4) any act of transgression against what someone or a society defines as just and as a right. Consequently, violence is an act of brutality, harassment and physical and / or psychological abuse against someone and characterizes intersubjective and social relationships defined by oppression and intimidation, fear and terror.

According to research carried out in several countries around the world, few topics have received as much attention today as violence. For many authors, one of the greatest symbols of today is the lack of security, the inability to protect themselves, the fear that violence in its various forms may affect us, whether as a participant in a society or in an isolated way. , destabilizing individualities (Hall, Stuart 1975; Boudon, 1993; Bourdieu, 1997).

Violence cannot be framed only in the act of practice and punishment. It is necessary to be attentive to the process in which it was formed, how it was built and what relationship it has with conflicts. Following this reasoning, Habermas (1981) points to a vision that is based on new forms of conflicts, those that are related to cultural reproduction, those that are generated from socioeconomic inequalities, social integration and socialization. It also states that these types of conflicts / violence are materialized in ways of life. To talk about violence, it is necessary to contextualize, analyze the relationships and types of society.

According to Bourdieu, (2001) the concept of violence can be metaphorical or symbolic.

The knowledge that is constructed in different experiences and coexistences, diverge on conceptual frameworks in relation to the theme. Violence is a concept that transitions between the metaphorical, the symbolic, as well as between legal definitions that require examinations of the body of crime and material evidence to configure what is meant by punishable violence. Symbolic violence can be exercised by different institutions of society: the State, the family, the school, the media, etc. Symbolic violence is expressed in the "legitimate" and disguised imposition, with the interiorization of the dominant

culture, reproducing work relationships. (Bourdieu 1970, apud L'Apicciarella).

A criticism of this concept comes from Habermas (1981) and refers to violence always being equivalent to physical aggression, therefore external to the symbolic. In addition, this criticism restricts violence only to the physical dimension, does not contemplate and analyzes the possibility of dominant beliefs to impose values, habits and behaviors without necessarily resorting to physical aggression, which creates situations where those who suffer symbolic violence feel abused, inferiorized and assaulted, as is the case, for example, in matters of bullying.

Other authors believe that being violent is something that man brings with him, however, this attitude of violence may or may not occur. The environment and the social condition in which he is inserted is who will define his violent posture or not. They also claim that in many cases, being violent is a matter of survival, sometimes in the face of the very nature that created it, and sometimes through others. (Arblaster 1996, apud Castro 2002).

Chesnais (1981) states that the only popular knowledge of the concept of violence is that which deals with physical violence, actions and or episodes that can cause irreparable damage to individuals and, as a result, awaits the intervention of society through the State . For the author, this is the only etymologically correct conception, because for him, "in addition to finding support in the penal code and in the perspectives adopted by some professionals, such as doctors and police officers". With this definition, the author excludes moral, symbolic and economic violence (that which occurs against property, or that results in deprivations of an economic order). Thus, talking about violence within the scope of Chesnais' analysis, implies referring exclusively to the so-called "harsh violence".

The fact is that conceptualizing violence is quite complex, but there are parameters that help direct authors to move towards an idea based on a common core. According to Michaud (1989), they are: "the notion of coercion or force and the damage that is done to an individual or social group (social class or category, gender or ethnicity), violation of human rights and senses for the victims, therefore being It is basic to privilege, in the concept of violence, both civilizing principles over rights - since often those who are devoid of them do not have objective conditions or parameters to recognize themselves as victims - as the perceived, the meaning, the assumed as suffering, pain or damage".

In this sense, it is worth recovering Michaud's definition:

There is violence when, in a situation of interaction, one or more actors act directly or indirectly, massive or sparse, causing

damage to one or more people to varying degrees, either in their physical integrity, in their possessions or in their symbolic participation and cultural (Michaud, 1989, 10 and 11).

Considering violence merely as a physical issue, deconstructs all the achievements acquired in recent decades through the consolidation of human rights, the recognition of humanity in its most diverse identities, diversities and the respect due to these. Following this reasoning, the prejudices resulting from the issue of gender, race, generation and class, among so many others, and their manifestations are considered, today, also violations of those rights.

Another way of conceptualizing violence as a social phenomenon is that exercised by the State or Institutions linked to it. From this perspective, violence is often confused with coercion, whether this occurs explicitly or not:

If violence does not necessarily involve physical aggression in the direct confrontation of some people with others, then the distinction between violence and other coercive ways of inflicting harm, pain and death is blurred. A policy that deliberately or consciously leads to the death of people from hunger or disease can be called violent. This is the reason why slogans like "poverty and violence" or "exploitation and violence" are not just hyperbole. (Arbastler, 1996: 803 apud Castro, 2002)

Within this perspective, no one better to speak of the violence exercised by the State than Althusser, when in "The Ideological Apparatus of the State" he demonstrates the influence and the dominion that He exercises over man. For Althusser, there is no way to unify the repressive and ideological apparatus of the State, as the repressive is structured in the use of force (violence), while ideology is used to act in the other areas in which "force" is also used, to reproduce the will of the State, such as: the family, the school, the religion, the judiciary, the political party, the union and others. The author also makes a distinction between the power of the State and the apparatus of the State, the latter being the body of institutions that constitutes the repressive apparatus of the State and the body of institutions that represent the body of the ideological apparatus of the State.

The role of the State's repressive apparatus consists in guaranteeing by force (physical or not) the political

conditions of the reproduction of relations of production, which are ultimately relations of exploitation. The apparatus of the State contributes to its own reproduction and also ensures, through repression, the political conditions for the exercise of the ideological apparatus of the State. Ideology is a "representation" of the imaginary relationship of individuals with their real conditions of existence.

In the literature, the relationship between power and the exercise of violence is common. However, for Arendt (1994), the conceptual distinction between power and violence is essential if the intention is to "deduce actions to contain it [violence], mitigate it or eliminate it":

Power, even though it may be questioned in its meaning or action, is supported, to a greater or lesser degree, by some level of group consensus. In violence, on the contrary, we are submerged in the field of arbitrariness where law and law, bastions of civilization, are banned. Or, in other words, the extreme form of power is all against one, the extreme form of violence is of one against all. (Arendt, 1994: 35)

3.2 - Violence in the Brazilian Context

According to the most varied authors, violence in the case of Brazil is intrinsically linked to issues of social macrodynamics. It also points to the role of the State and also addresses rural issues or rural issues. For these thinkers, factors such as: social inequalities, poverty, unemployment, economic crises, inoperative public power, bureaucracy, slowness of justice and democracy are some of the most debated macro-structural references, but with a unique approach, according to each author.

Mesquita Neto et al. (2001) highlights that the violence caused at the expense of political actions occurs mainly within the same social class, that is, among people of the same socioeconomic level. The author also stresses the need to debate more deeply the conflicts called classes. He concludes his statement, saying that "the dynamics of political economy would be more successful when the analytical level was institutional". Within this perspective, one must understand the interpersonal relationship in what the author calls the "microsocial level".

Peralva (2000) does not agree with the idea that there is necessarily a connection between violence and phenomena called macrosocials. When she writes about the issue of violence in Brazil, she points out and recognizes that there are relations between them, but that these points do not necessarily generate violence. It also states that social inequalities, the uncontrolled periphery of cities, the poor distribution of income, among others, explain in some cases the practice of violence, but it does not justify it. One of

these “relations” pointed out by her is the fact that reports of violent deaths in poor neighborhoods are common and rarely occurred in wealthy neighborhoods.

For Pinheiro (1996), there is violence of an “endemic character”, linked to social issues. This type of violence is translated through authoritarian attitudes of various orders.

“Territorial underdevelopment (of populations in the North and Northeast and of urban and rural areas in other regions); impunity - corruption, as in the area of security -; abuses by police forces, especially against the poor and non-whites; violations of the rights of poor prisoners; and racial discrimination.”

However, it is already common in contemporary Brazilian literature, the authors' recognition, regarding the authorities' concern regarding the importance of “respecting both the rule of law and international human rights norms, although much remains to be done. done”(Pinheiro, 1996, p. 9); “Improving the register on violence, making what is available on the topic more visible and detailed”(Mesquita Neto et al. 2001); “The increase in the number of security personnel and their training, even though it is insisted that “structural violations” of social, economic and cultural rights seem to be a characteristic of society” (Pinheiro, 1996, p. 22).

Peralva (2000), while still writing from the perspective of democracy, incomplete citizenship and violence, lists the main reasons that contributed and contribute to a scenario that potentiates violence in the most diverse regions of the country, whether they are large urban centers or even even small and medium-sized ones: “1) increased access to weapons - an aspect emphasized by several interviewees in different surveys, in areas of poverty (Peralva, 2000; Zaluar, 1999; Castro and et al, 2001, among others); 2) “juvenilization” of criminality; 3) greater visibility and reaction to police violence, particularly against young people in peripheral neighborhoods; 4) expansion of the drug and firepower market for organized crime, especially drug trafficking, in different urban centers; and 5) individualistic and consumption culture - “mass individualism” - derived from unmet expectations, potentiating violence”.

As advocated and proposed by other authors, Peralva (2000) points to the need for greater reflection on the role of the State in terms of legitimacy in controlling violence. It also defends the insertion of low-income populations and civil society in the construction of the democratic game, besides considering reform as important in the police, as in justice - “having a respected and respectable police” (Peralva, 2000, p. 187) . Following the Weberian thesis of the centrality of

the State in the disciplining of violence, Peralva (op. Cit, p. 22) defends that:

Only the State is able to embody the will that the common law be respected, which supposes that it exercises functions of controlling transgression and exercising punishment. Building a State that, in the name of civil society, is able to effectively control the functioning of all institutions, without, however, contradicting the principle of individual freedoms, is probably one of the most important problems that Brazilian democracy will face in near future.

The antagonisms that exist in Brazilian democracy are also verified and cited, even with other views by Mesquita Neto et al. (2001) who, when rescuing the perspective - economic, political and social - pro-violence dimensions, insists on the issue of governance and considers that:

The growth of crime and violence results not only from poverty and social inequality, the lack or poor quality of security services and the spread of weapons and drugs. It also results from political uncertainty and unresolved institutional conflicts during the transition to democracy, which weaken the impact of actions to improve security and justice services. (Mesquita Neto et al., 2001, p. 34)

According to Vieira (2001), a society of peace is only built if the authorities manage to eliminate the ghettos, the great social gaps, that is, it is necessary that the whole society feels inserted in a common culture, sharing and co-sharing of norms and values. Still according to Vieira, (2001, p. 81) “racism, poverty, lack of access to education and essential goods, to human dignity are ways that facilitate the perception of the other as inferior (...)”. It also points out that while the most developed countries invest around 6% of the GDP in education, Brazil invests just over 3%.

IV. SCHOOL AND VIOLENCE

4.1 - Violence at School: A New Phenomenon?

The school community thinks that violence at school is a new phenomenon, which would have appeared around the 1980s and which developed more intensely in the 1990s. The fact is that, historically, the issue of violence at school is not so recent . In the nineteenth century, some very violent demonstrations took place in certain high schools, sanctioned with imprisonment. However, if violence at

school is not a radically new phenomenon, it takes forms that are new.

In the first place, the violence took totally different forms from what happened previously, and then there were facts that were much more serious than in the past: homicides, rapes, assault with weapons. It is worth noting that these facts are sporadic and in some rural cities there are no records of this, but they give the impression that there is no longer any limit, that, from now on, anything can happen at school. These actions contribute to producing what could be called social anguish and impotence in the face of violence at school. Added to this, the attacks on teachers and other school staff or the insults directed at them are already routine: there, too, a limit seems to have been crossed, which increases social distress.

Second, young people involved in violent practices are increasingly younger. Students aged between 8 and 13 years are sometimes violent even towards adults; Early childhood teachers (nursery, day care and pre-school) say they are also faced with new phenomena of violence in four-year-olds. Statements by teachers and parents reporting acts of extreme violence by very young children, around six, seven and eight years, are frequent. It is the representation of childhood as innocence that is attained here, and adults today wonder what these children's behavior will be when they become teenagers. There is also a source of social distress in the face of school violence.

Third, those who make the school team (teachers, support staff), from neighborhoods that are considered "problematic", are often targets of repetitive actions, which are not directly considered violence, but that the accumulation and incidence generate a constant tension in the school environment. The proof of this "tension" is the frequent fire sirens firing, several times a day.

This social anguish resulting from these phenomena increases even more, when the case of violence, even very serious, occurs in schools in the small cities of the country that should "escape" due to the fact that they are located in spaces where violence does not seem to be common. This school violence seems to have no end, despite the "plans" and measures adopted by the authorities for decades. Faced with this, school violence takes on a new guise: now it has become something structural and not accidental, as was previously thought.

4.2 - The School Violence Trilogy

Initially, it is necessary to distinguish violence at school, violence at school and violence at school.

Violence at school is what takes place within the school itself, but it is not necessarily linked to the nature and activities of the school institution: "when a gang enters the

school to settle accounts of the disputes that are in the neighborhood, the school is only the place of violence that could have happened anywhere else. However, one can ask why the school today is no longer sheltered from violence that once stood at the doors of the school "(Charlot, 1997).

As long as the country's structural and social problems are not resolved, the school will continue to be the scene of constant violence, whether physical, moral, verbal, social or economic. With an aggravating factor: not being able to do much to reverse this situation, since young people (students) will always be exposed to marginalization in the community in which they live. Thus, the school places itself, therefore, only as a spectator of violence and school failure.

Violence at school is linked to the nature and activities of the school institution: students, when causing riots, fights, riots, fires, verbally, morally, physically assault or insult teachers or other school staff, deliberately practice the so-called school violence. This type of violence against the school is often the result of a way of drawing attention or protesting against the authoritarian type of management, evaluation method and discrimination that they suffer every day at school.

The other way in which school violence occurs is that exercised by the school itself, called school violence. It can be considered institutional violence, which Althusser alludes to, promotes symbolic violence that young people themselves endure through the way the institution and its agents treat them. Such violence can manifest itself in several ways, such as: "ways of class composition, grading, guidance, contemptuous words by adults, acts considered by students to be unjust or racist ...".

Several theorists claim that violence at school and that at school are closely linked, but they are not the same. While one is the attack of the result of its proliferation in all sectors of society and the means used by students to protest and claim, the other uses the power constituted by the State to exercise its thoughts, ideologies and even regrettably atrocities.

It is necessary to separate these three types of violence, because if the school is largely (but not totally) impotent in the face of violence in the school, it has (still) scope for action in the face of violence against the school and the school.

An exemption should be sought on the issue of defining the problem of youth violence that inflicts and or attacks those who make up the school. It is true that young people are the main actors of those who cause violence, but they are not the only ones who cause it. If on the one hand they are the cause, on the other hand they are also the main targets. It is not yet possible to disassociate the issue of school violence from the question of students victimized by this violence.

For some thinkers, it is difficult to distinguish those who are the cause and those who suffer from violence, because they are very similar. According to Abramovay (2003), the profile of young people involved in this statistic is: "boys (but the violence of girls is currently increasing), students with family, social and school difficulties (that is, students enrolled in qualifications, in establishments, in departments or more devalued classes) ". It also reinforces another group, that of young people who suffer from unemployment, road accidents, drugs, sexual assaults, etc.

Believing that violence and, consequently, conflicts can disappear is undoubtedly utopian. Although this is the desire of practically every human being, except for those whose nature is quite distorted. It must be taken into account that in some areas (some sports, in art, etc.), they (violence and conflict) are considered to be important or, at the very least, necessary. On the other hand, isn't conflict the engine of history, as Hegel thought? What must be analyzed is what may or may not be considered "acceptable" within this violence or conflict. When it manifests itself with the intention of destroying, debasing, tormenting, it must be quickly restrained and avoided, especially at school, a place of symbolic and not physical conflict.

4.3 - Violence as an Abyss Between School and Society

When analyzing school spaces whose incidence of violence is high, there is a situation of strong tension among those who make the school team; conversely, when looking at those looking for a reduction in violence, there is a management team and teachers who seem to reduce the level of tension. This is, possibly, the main point of how to mitigate this issue: the handling of saber acting as a mediator, of intermediating, of placing oneself as a judge. The most violent actions are variable against a background of strong social and school tension; cases, a simple spark that comes (a conflict, sometimes minor), causes the explosion (the violent act). Therefore, it is necessary to dedicate oneself to the sources of this tension.

This can lead to the understanding that if the school is inserted in a traditionally violent neighborhood, it will also become violent. This combination is likely to occur, but what about schools that are available in upper-middle or wealthy neighborhoods whose violence rate is relatively lower than the others and still have a high rate of violence? Therefore, directly associating school violence with the neighborhood's socioeconomic situation can be a mistake. But the empirical data shows that the rate of production produces complex and, at times, contradictory effects:

It is a source of school demobilization (students say that it is not worth learning, since, anyway, with their diploma, they do not find work), but also, and peculiarity, for some students, it is a source of school mobilization (young people

say that, therefore, more and better diplomas are needed). (Abramovay, 2003).

It is worth discussing here one of the school's social functions, the social compensation function, that is, to mitigate existing inequalities between the richest and the poorest. Since the end of the 60s of the last century, it is clear that in order to have and enjoy a good job, it is necessary to study. In other words, it is their future life that young people play at school.

There is a source of strong tension in the school universe. This tension is even stronger because the representation of the school as a way of professional and social insertion erased the idea of the school as a place of meaning and pleasure. So that the gap is growing between the importance of school (which allows us to ascend to a desirable, or at least "normal" life) and the emptiness of school in everyday life (where young people, especially in the media) learns things that are meaningless to him). (Abramovay, 2003).

Therefore, it is necessary, therefore, to review the concept of the role of the school in the formation of the citizen, of what is education, of what is violence in school and also of what is school management. Knowing how to assemble a team capable of mitigating or, if possible, extinguishing the issue of violence is the main point for reversing this phenomenon.

This is certainly an issue that is linked to the state of society, forms of domination, inequality, an issue that is also linked to the institution's practices (organization of the establishment, rules of collective life, interpersonal relationships, etc.). But it is also an issue that is linked to everyday teaching practices that, ultimately, constitute the heart of the school reactor: it is very rare to find violent students among those who find meaning and pleasure in school. (Abramovay, 2003).

To affirm this, evidently brings great and heavy responsibility on teachers and on those who do education, but, on the other hand, it also gives them a professional dignity that sociological works, establishing a direct relationship between the social and the school, tend to remove their.

V. RELATIONSHIP BETWEEN VIOLENCE AND SCHOOL DROPOUT

5.1 - Violence and dropout

Research has pointed out which are the social aspects that are seen as determining factors in the school dropout process: family breakdown, government policies, violence, unemployment, malnutrition, the school and the child himself.

According to Freitag (1980: 61) when analyzing the issue of school failure in Brazil, in the 1960s and 1970s, he highlighted that:

Of the 1000 initial students in 1960, only 56 managed to reach the first university year in 1973. This means dropout rates of 44% in the primary year, 22% in the second year, 17% in the third year. They are associated with failure rates that between 1967 and 1971 fluctuated around 63.5%.

Following this same reasoning, however, in a more contemporary approach, Lahóz (in Revista Exame, 2010) states that of every 100 children who started their studies in 2017, only 81 will reach the 9th grade.

These data raise a very worrying issue. It involves not only a micro angle (school), but also and directly the macro level (the state and the country). In return, numerous governmental measures have been and are being taken to mitigate and perhaps eradicate school dropout. Examples of these attitudes are: the implementation of the Escola Ciclada, the creation of the Bolsa-Escola program, the implementation of the School Development Plan (PDE), among others. These actions are certainly important, but they have not been sufficient to guarantee the child's permanence and promotion in school.

Thinking about dropping out of school, just as a school problem, does not seem to be the most correct way to approach the subject, as it is also a national issue that has been playing an important role in educational discussions and research in the Brazilian scenario. As well as the problem of illiteracy and the devaluation of education professionals, who manifest themselves in low remuneration and in precarious working conditions, often limiting the teacher to having only a blackboard and chalk. To the detriment of this, Brazilian educators are increasingly concerned with children who arrive at school, but who do not remain there.

In a general approach, school failure is studied from two different themes: the first, which seeks explanations from factors external to the school and the second, from internal factors. The main external factors that are attributed to the

issue of school failure are pointed out: work, social inequalities, the child and the family. Among the intra-school factors are listed the school itself, the language and the teacher.

Brandão et al. (2013), points out in research carried out by the Joint Studies Program for Economic Integration in Latin America (ECIEL), using five Latin American countries as the reference for analysis and concluded that the most important factor in understanding the determinants of school performance is the the student's family, and the higher the mother's level of education, the longer the child stays in school and the higher his or her income.

In this perspective, the family was identified as one of the most important biases that determines the child's school failure. This can occur due to the family's life condition or because it does not follow the children's school life and activities.

The social inequalities pointed out by the ECIEL survey are also present in Brazilian society. For Arroyo (1991: 21), this is the result of "class differences", and it is they that "mark" school failure in the least favored part of society, because:

It is this school of the working classes that has been failing everywhere. It is not the differences in climate or region that mark the great differences between possible and impossible schools, but differences in class. Official policies try to hide this class character in school failure, presenting problems and solutions with policies and regional and local

In in-depth studies in national and international literature regarding dropout and repetition in the former 1st grade, now called Elementary Education, Brandão, Baeta & Rocha (1983), citing the studies of Gatti (1981), Arns (1978) and Ferrari (1975), explain that "students of lower socioeconomic level have a lower income index and, according to some authors, are more likely to drop out".

As for the question of students who attend school at night, they are the most prone to dropout. According to Meksenas (1998: 98), they are forced to work for their own and family support, exhausted from the daily marathon and unmotivated by the low quality of education, many adolescents drop out of school without completing high school. Still according to the author, this reality experienced by students from the least favored social classes is not the same as the reality of students belonging to the most affluent classes.

The child's culpability in the evasion process is observed through the theories that explain the "ideology of gift and the ideology of cultural deficiency", Soares (1992: 10-3).

According to the author, this ideological bias removes the responsibility for the student's school failure from the school, because she argues that on the one hand there is an absence of basic conditions for learning, and on the other, due to her condition of life, therefore, for "having cultural disadvantages or socio-cultural deficits".

On the other hand, there are those who defend external factors as determinants of children's school failure. Bourdieu, Cunha, Fukui and others delegate to the school the responsibility for the success or failure of students in public schools. They are based on explanations that go from the reproductive character of the school, to the function of the school and to the pedagogical practice of the teacher.

Contrary to the authors who point the child and family as the main responsible for school failure, Fukui (in Brandão et al, 1983) reaffirms the responsibility of the school when he says that the phenomenon of dropout and repetition is far from being the result of individual characteristics of students, students and their families. On the contrary, they reflect the way in which the school receives and exercises action on the members of these different segments of society.

Bourdieu (in Freitag, 1980), points to the fact that if it is the working class schools that have been failing, the authors believe that this is nothing more than the result of reproduction, domination and maintenance of the interests of the dominant classes.

Some authors argue that the school does not consider the student's cultural capital. Against this idea, Bourdieu (1998), states that teachers start from the hypothesis that, between the teacher and the teacher, there is a linguistic and cultural community, a previous complicity in values, which only occurs when the school system is dealing with their own heirs.

On the other hand, there are those who claim that the responsibility for the student's failure rests with the teacher. For Rosenthal and Jacobson (in Gomes, 1994: 114) the responsibility of the teacher for the student's academic failure is due to the negative expectations that he has in relation to his students considered as "disabled", who, many times, present behavior in accordance with what the teacher expects of them. The teacher, according to the authors, ends up practicing the so-called "self-fulfilling prophecy".

According to Gatti (in Brandão et al, 1983: 47), the phenomenon of self-fulfilling prophecy is more likely to occur in a school that includes children of different economic levels, which leads to comparisons and preference of teachers in favor of children closest to them in cultural terms.

Discussing the problem of school failure goes much further than pointing out those responsible. For Charlot (2000: 14), the problem refers to many debates that deal with learning, obviously, but also about the effectiveness of teachers, about the public service, about the equality of "chances", about the resources that the country should invest in your educational system, about the "crisis", about the ways of life and work in the society of tomorrow, about the forms of citizenship.

Still for Charlot (2000), school failure does not exist, what there are in fact are students in situations of failure, because they are unable to learn and adapt to the parameters that the school believes to be correct. Because they do not build certain knowledge or skills, they call them "failures". This failure generates, in most cases, a behavior of retraction, disorder and aggression that culminates, many times, in violent attitudes.

VI. RESULTS AND DISCUSSION

Of the fifty questionnaires delivered, eight were not returned, that is, 16% did not answer or did not return them within the pre-established time by the school management. Although with this gap, normal in any field research, the results obtained were not compromised and, on the contrary, offered a new angle of discussion in order to prove that in some cases the debate on violence is given as a synonym for "fear", "Danger", preferring some to abstain from any responsibility. The data that follow in graphs and analyzed, corresponded to forty-two students from the five schools involved in the research, who received the questionnaire, or 100% of the questionnaires returned. In some questions with more than two answers, the interviewee could check as many options as he / she would like and the percentage sum would be given in relation to the total number of respondents per answer given to each item asked and answered in the same question.

The analysis of each question in the questionnaire occurred with the presentation of a graph, showing the numbers obtained in percentage form. Each of them was also compared with Dr^a Abramovay's research, since it is the most complete analysis of the problem of school violence and its consequences, carried out in Brazil, in the last two decades. Therefore, for the theoretical framework, it will focus solely and exclusively on Abramovay's "Violence at School" (2003), a partnership between the University of Brasilia and UNESCO.

6.1- Analysis of Student Data

When asked in the first question of the questionnaire for students in public schools in Feira Nova, if they knew what violence is, all respondents answered yes, that is, 100%. The

answer “yes” does not seem to be a surprise in view of the constant and current picture of indiscipline and violent acts witnessed in homes, streets and schools across the country. This truth was also demonstrated in Abramovay's work,

carried out in the main capitals of Brazil, where all the students interviewed claimed to know what violence is. The data of students from the municipality of Feira Nova - PE, can be seen in Graph 1.

Graph 1: Do you know what violence is?

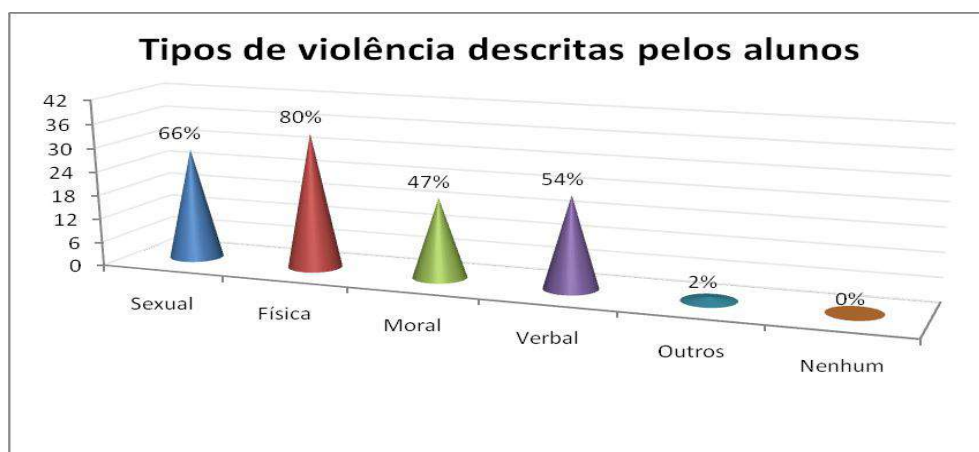


Source: Author / 2009.

In the second question, six answer options were given so that the student could indicate which of the types of communication he knew. It was considered in the questionnaire to be assigned to the options assigned to it. 66% replied that they knew what sexual violence was, 88% of the interviewees said they knew the type of physical violence, 47% said they knew what moral violence was, 54% reported that they know what verbal violence is, only

2% mentioned another type of violence. violence. Once again, local research confirms what was previously researched by other scientists dealing with this theme. Especially the one elaborated by Abramovay and team. This information is even more accentuated in the large metropolitan centers of the country where living with violence has become routine in the lives of students. The numbers are shown in graph 2 below:

Graph 2: Do you know what are the types of violence?



Source: Author / 2009.

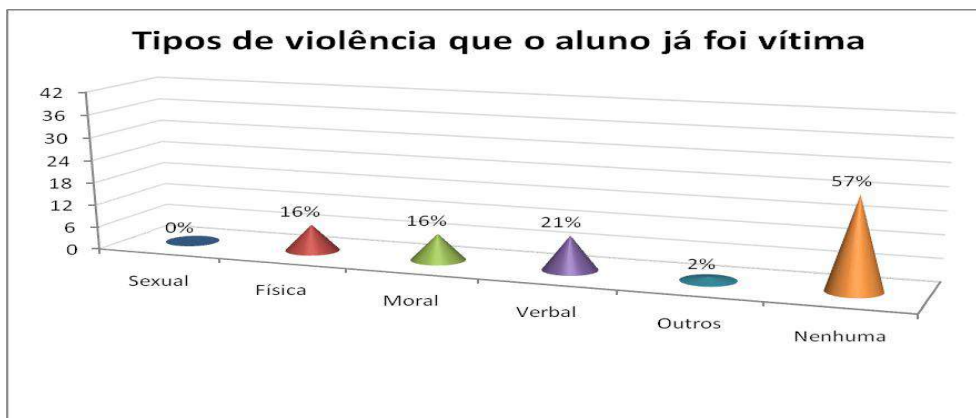
At the moment when the questions were tapering off and asked if they had already been victims of some type of violence, the answers were quite forceful as to the type suffered by each one of them. 100% have never suffered any

type of sexual violence, 16% of respondents say they have suffered some type of physical violence, another 16% have experienced moral violence, while 21% cited having been the victim of verbal violence, 2% of respondents declared

other types of violence suffered and 57% of them stated that they had never suffered any type of violence. Abramovay believes that due to fear or trivialization of violence, the number of victims is even greater and that because it is routine, students become accustomed in such a way that it is so “normal” that some practices they suffer are not even

violence. If the research data of this work is compared to those published in the book "Violence at School", you will notice that there are no major differences, despite the fact that the two fields of study are so different. These data can be confirmed in graph 3 of this research:

Graph 3: Have you ever been a victim of some type of violence?



Source: Author / 2009.

In item four of the research, it was asked whether they have witnessed any type of violence at the school in which they study, if they had witnessed it, which of the types of violence occurred in their study environment. For 100% of the interviewed students, in their school there has never been or witnessed any type of sexual violence; for 47%, physical violence occurred at school and they witnessed it, 26% of students answered that at their school they witnessed moral violence, for 47% of students there was also some type of verbal violence among school members, 2% of those surveyed they said they had witnessed other

types of violence and another 16% claimed they had never witnessed any type of violence at the school where they studied. It is clear, in this work, some points already verified by other authors, such as the absence of sexual violence practices, for Abramovay, the fact that the school is a place where there is a constant movement of people, this bias is something “thought” before execution, other facts such as physical, moral and verbal violence are more common to occur, either due to the fact that the practices. See the analysis of this information according to chart number 4:

Graph 4: What types of violence have you seen at school?



Source: Author / 2009.

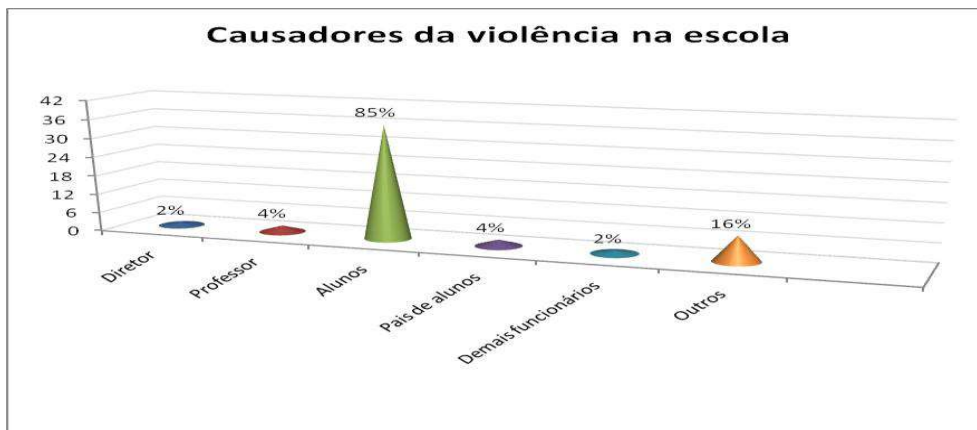
The fifth question asked to the students of the interviewed schools was: in your school, who practices the acts of violence: teachers, principals, students, other employees, parents of students or third parties? 2% of the interviewees

stated that the principal is the person who causes some type of violence, for 4% of the interviewees it is the teachers who cause violence at school; 85% replied that the cause of the violence is the students themselves, for 2% of the

interviewees those who practice violence are other school employees, for another 4% who cause violence in the school are the parents of the students and 16% of them answered that they other elements that are the motivators and cause of violence at school. It is believed that, in the surroundings of

the school, most of the elements that cause violence practiced by third parties are concentrated, that is, agents that are not directly part of the school community. This practice is often linked to the issue of drugs and gangs. The information can be analyzed in graph number 5:

Graph 5: Who causes violence at school?

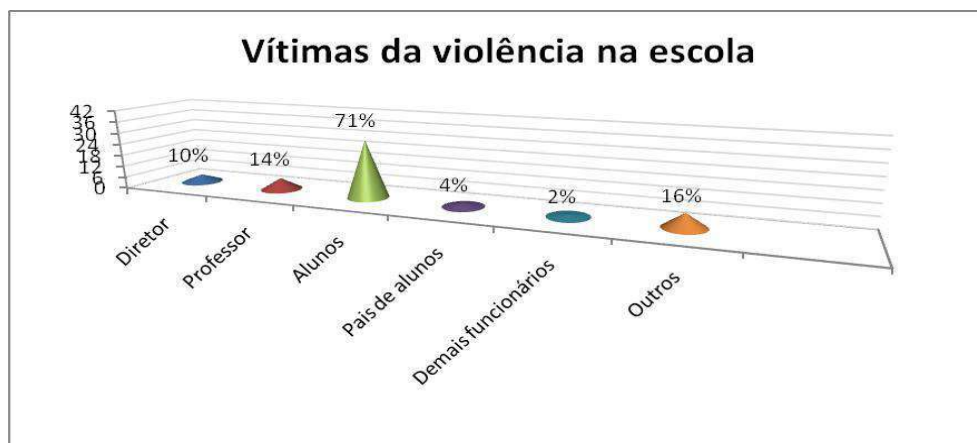


Source: Author / 2009.

In the sixth question, the students were asked about the victims who suffered some type of violence at school. For them, 10% of the victims of violence are the director; another 14% of victims of school violence are teachers; of the forty-two respondents, 71% stated that it is the students who frequently suffer some type of violence, for another 2%

the victims are the other school staff; for 4% of respondents, those who suffer violence are the parents of the school's students and for 16% of students who answered the questions are other elements who suffer violence, as described in Graph 6:

Graph 6: Who are the victims of violence at school?

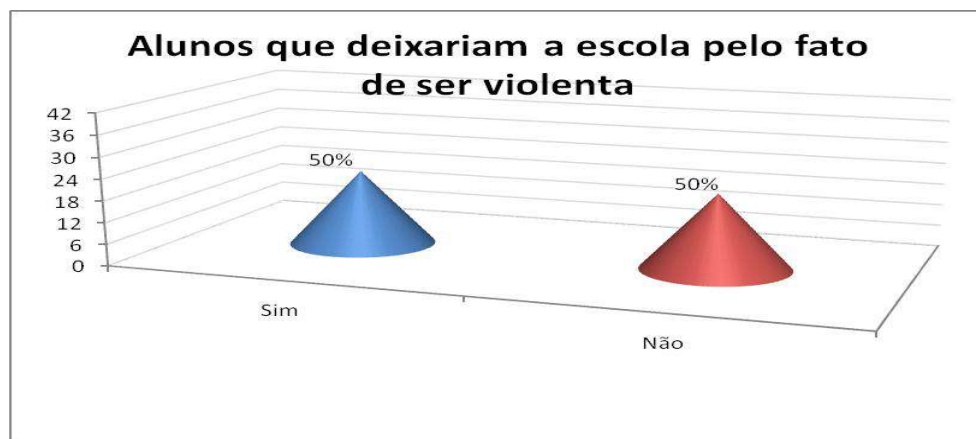


Source: Author / 2009.

When the students surveyed answered the seventh question that addressed the possibility of leaving the school due to the fact that it is violent, half of the students, that is, 50% answered yes, while the other 50% answered that they would not leave their school as a result she's violent.

According to other surveys, violence has been one of the most cited causes in explaining the transfer or dropout of schools among the eight most expressive metropolitan regions in the country. This information can be seen in Graph 7:

Graph 7: Would you leave your school because of the violence?

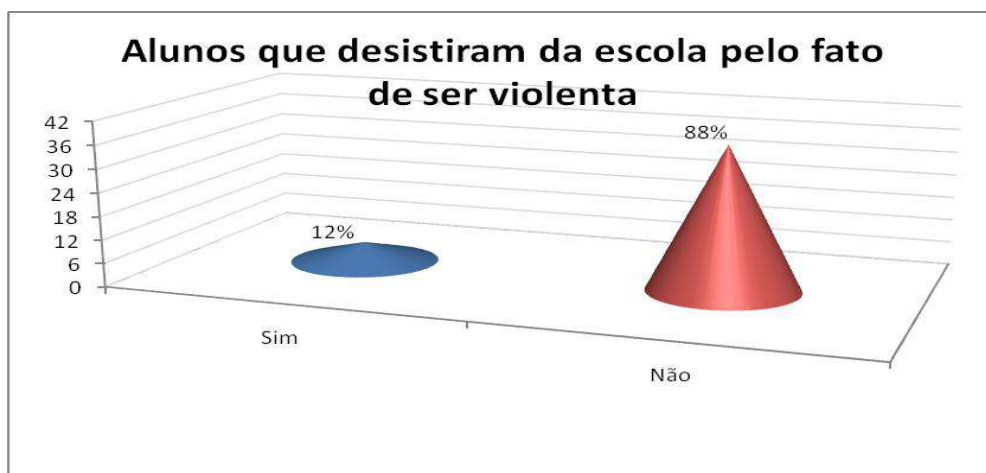


Source: Author / 2009.

And in the eighth and final question of the questionnaire addressed to students in the five schools, he asked himself if he knows someone who gave up studying in detriment of the constant practices of violence that occurred at school. Only 12% of respondents answered that they know students who dropped out of school because it is violent, while the other 88% answered that they do not know students who

dropped out as a result. In São Paulo, Recife, Rio de Janeiro, Salvador, Fortaleza and Brasília, according to Abramovay, the number of students who evade or transfer as a result of the violence is around 20%, something higher than the 12% presented in Feira Nova, to the detriment of the city having a history of violence quite different from the capitals mentioned above. According to graph 8:

Graph 8: Do you know students who dropped out of school because of violence?



Source: Author / 2009.

VII. FINAL CONSIDERATIONS

This work dealt with the theoretical concepts formulated by researchers regarding the issue of social and school violence and the problem of school dropout. It went through the origins, motives and the consequences of its achievements. The question of the relationship between teacher, manager, student and family was raised, showing how the interaction between them can mitigate even eliminate such problems. It is also perceived that the correction of these can facilitate the learning process and help to improve the relationship between teacher and student in all aspects.

One could not fail to consider what attracted the most attention when confronting the questionnaire data applied to students, teachers and managers. All of them declared that they knew, defined and lived with at least one or two types of violence and that they still recognize this aspect as a major problem to be solved in Brazil. They also affirmed that school dropout is something common to their coexistence and that in case their school is not able to control the problem of violence, they would stop attending them.

Seeking to understand these facts is what this work proposes to do. Conduct an analysis of the events and reasons that generate violence, evasion and the harmful results left by these practices, pointing through data, the alarming numbers, results of a chaotic combination (violence and school failure).

It would be pretentious to think that the issue of violence in all its forms and also the issue of school failure in one of its greatest expressions, evasion, is reduced to this work, as there is still much to be researched, discussed and analyzed about the subject. subject matter. The open questions of the questionnaire, which was applied in this research, can still be analyzed in a more systematic way, using other statistical treatments.

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Nursing assistance in COVID-19 cardiovascular complications: Integrative Literature Review

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Keywords— COVID-19. Cardiology. Nurse.

Abstract— This study aims to describe the aspects related to nursing care in cardiovascular complications of COVID-19. This is an integrative literature review, carried out in March 2021, through the search for articles in the scientific databases, published between January 2020 and February 2021. For the treatment of the data, the analysis technique was used of content 04 complete original articles were selected that answer the central question of the research and that were organized in three categories according to the evidences found. The analysis of the literature shows that the articles address nursing care through teleconsultation, nursing care in the cardiac complications of COVID-19 and nursing management in a cardiological unit in the context of the COVID-19 pandemic. It is concluded that nursing has a wide field of action in the front line and great challenges are faced when dealing with a new disease. The losses of COVID-19 to the cardiovascular system are present in the short and long term and nurses play an important role in the prevention, diagnosis, monitoring, treatment and rehabilitation of heart diseases.

I. INTRODUCTION

The emergence of a New Coronavirus, officially known as Severe Acute Respiratory Syndrome (SARS-CoV-2), the cause of COVID-19, presented an unprecedented challenge for the whole world.[1]

In addition to the classic symptoms, the virus can affect the cardiovascular system and cause several clinical manifestations such as myocardial injury, Heart Failure (HF), Takotsubo Syndrome (ST), arrhythmias, myocarditis, Acute Myocardial Infarction (AMI) and shock [2]. Furthermore, the association between COVID-19 and previous cardiovascular disease is related to worse outcomes and increased risk of death.[3]

The damage caused by COVID-19 to the cardiovascular system is probably multifactorial and can result from an imbalance between high metabolic demand and low cardiac reserve, systemic inflammation and thrombogenesis.[4] Initial data suggest that those with COVID-19 and hypertension or cardiovascular disease have a mortality rate of 2 to 3 times higher than the population that is affected by the virus in general, suggesting that they are highly susceptible to the most serious effects of the disease. [2]

The virus has also been linked to long-term cardiac damage as it has also stopped treatment of people with existing cardiovascular disease. Some of the drugs that have been examined to treat the SARS-CoV-2 virus may be associated with long QT and arrhythmias. At the beginning of the COVID-19 pandemic, Hydroxychloroquine and Azithromycin assays to treat the New Coronavirus were established.[5]

However, these drugs can cause heart problems, specifically QT prolongation, especially in patients with liver disease or kidney deficiencies. In May 2020, the Australian Therapeutic Administration (TGA) updated its advice stating: "Based on the most recent international data, the use of Hydroxychloroquine to treat COVID-19 is strongly discouraged. The two main injuries to the cardiovascular system are: myocarditis and heart failure caused by the virus.[6]

Heart failure (HF) is a physiological state in which the heart is unable to pump enough blood to meet the body's metabolic needs after any structural or functional impairment of ventricular filling or blood ejection, refers to a clinical syndrome characterized by manifestations of volume overload and inadequate tissue perfusion.[7]

In the context of COVID-19, heart failure can present a set of unique challenges that can complicate presentation, management and prognosis. As a consequence of heart failure, myocarditis is a medical condition described as

inflammation of the muscular middle layer of the heart wall, called myocardium.[8] It involves necrosis of cardiac myocytes or cardiac muscle cells, can cause a cascade of signs and symptoms that can include fatigue, dyspnoea, palpitations and can lead to death.[6]

Myocarditis is usually idiopathic, however, it can also occur because of other diseases. The signs and symptoms are usually nonspecific and can mimic any other heart disease.[9] However, signs characteristic of heart failure may appear, such as fatigue, dyspnoea, edema, signs of fluid overload, crackles, elevated jugular venous pulses, as well as the presence of 3rd and 4th heart sounds, systolic murmurs and chest pain.[10]

A multicenter cohort study involving 191 patients hospitalized with COVID-19 in Wuhan, 48% of patients had some comorbidity (67% of those who died), 30% had hypertension (48% of those who died), 19% had diabetes (31% of those who died) and 8% had coronary heart disease (24% of those who died).[11]

Although the virus enters the body through the upper respiratory tract, its affinity and selective binding to the angiotensin-converting enzyme 2 (ECA2) receptor, which is abundant in the endothelium of arteries and veins as well as in the epithelium of the respiratory tract, creates an ideal scenario in which COVID-19 develops with the potential for serious vascular complications. This may explain why hypertension is one of the cardiovascular conditions associated with adverse events.[9]

COVID-19 is a new disease, still in the process of discovering the extent to which it can cause health problems, whether in the short or long term. Nursing, as a category so present in patient care, needs to be prepared to know how to better manage the clinical situation of cardiac patients.[12]

In view of this situation, nurses working in cardiology have faced several challenges, since cardiac patients require stability and safety in care, in diagnoses, treatment, education and adequate follow-up.[5]

From the knowledge of the problems caused by COVID-19 in cardiovascular condition, some care must be adopted by the nursing team, who must be attentive during their visits, whether in primary or hospital care, about the clinical history, physical examination, troponin levels and electrocardiogram (ECG).[13]

The nurse has a fundamental role in the health team in the daily monitoring of patients, because through clinical evaluation, they will be able to survey and evaluate data for decision-making with the multidisciplinary team. Although attention is focused on addressing the acute situation created by the disease COVID-19, it is important

to continue efforts to prevent cardiovascular morbidity and mortality.[12]

The main functions of the nurse in the management of heart failure have focused mainly on the follow-up and monitoring of patients. The goals of the nursing care plan include support to improve the function of cardiac pumping through various nursing interventions, prevention and identification of complications.[14]

HF usually begins with increasing shortness of breath, sometimes accompanied by unspecific signs and symptoms of edema, fatigue, loss of appetite and changes in weight. HF may not be detected until the patient actually presents the signs and symptoms of pulmonary and peripheral edema. In view of this, nursing assessment focuses on observing the effectiveness of therapy and in developing care strategies.[15]

Some important nursing care are cardiac auscultation, as well as heart rate and rhythm to detect possible arrhythmias, palpation of peripheral pulses, blood pressure monitoring, skin tone checking for signs of pallor or cyanosis and production monitoring of urine, carefully observing the decrease in production and also the concentration.[15]

It is also important to assess the mental state and the level of consciousness, as well as to observe changes in the pattern of behavior such as lethargy, confusion, disorientation and anxiety. Assessing the patient's respiratory condition is of great importance, as well as paying attention to signs such as dyspnea, shortness of breath, fatigue and edema by monitoring oxygen saturation and a complete physical examination.[15]

Nursing care in heart failure consists of assessing vital signs at least every hour, increasing the intervals between taking vital signs as they stabilize, starting to be checked every four hours; administration of supplemental oxygen, as prescribed, and interrupting the oxygen saturation level (SpO₂) if it is above the target range or as requested by the physician [15].

This study aims to describe aspects related to nursing care in cardiovascular complications of COVID-19.

II. METHOD

The research is of the type of integrative literature review, which aims to gather and synthesize research results on a delimited theme, in a systematic and orderly manner, being an instrument for the deepening of knowledge about the investigated theme, allowing the synthesis multiple published studies and general conclusions about it.[16]

In carrying out this review, six steps were used: 1) selection of hypotheses or guiding questions for the review; 2) selection of studies that will compose the sample; 3) definition of the characteristics of the studies; 4) categorization of studies; 5) analysis and interpretation of results; and, 6) report of the review.[17]

The guiding question for the elaboration of this integrative review consisted of: What are the scientific productions available on the aspects related to nursing care in the cardiovascular complications of COVID-19?

The survey of bibliographic studies took place during the month of March 2021 and four databases were chosen: Virtual Health Library (VHL), PubMed, Medical Literature and Retrieval System on Line (MEDLINE) and Google Scholar.

Following, the validated DECS descriptors were used: "COVID-19"; "Cardiology" and "Nursing", the Boolean AND operator was used, in Portuguese, Spanish and English, published between January 2020 and February 2021.

For data collection, it was decided to use the instrument validated by Ursi [17]. The analysis of the selected studies took place in a descriptive manner, in order to enable observance and description of the data, thus, it was possible to gather the synthesized knowledge on the subject in question. Based on this, two empirical categories were elaborated, which will be presented and discussed below, in which the content analysis method of Bardin [17] was used to explore the content.

To guarantee the success of this study, it was decided to describe and distribute the results in tables, highlighting the main findings of each research. As for the discussion, it was carried out in a descriptive manner, in order to achieve the objectives of building an integrative review.

III. RESULTS AND DISCUSSION

In the present integrative literature review, 04 original scientific articles were selected that strictly met the selection of the sample previously established and showed approximations with the object of this study. These were organized in alphanumeric codes, from CV01 to CV04, for a better presentation and understanding of the results.

After analyzing the articles, three categories emerged, namely: 1) Nursing care through teleconsultation; 2) Nursing assistance in the cardiac complications of COVID-19; 3) Nursing management in a cardiology unit in the context of the COVI-19 pandemic.

Tables 1 and 2 show the characteristics of these studies, in which articles in English (80%), clinical trials

(60%), published in international journals (80%) and indexed in the Pubmed database predominate (80%).

Table 1: Distribution of studies.

Nº	Base	Language	Author. Title. Periodic. Year	Objective	Methodology
CV01	Google Scholar	Portuguese	SILVA, Vanessa Machado da. et al. Previous cardiovascular diseases and the risk of developing the severe form of COVID-19 in patients treated by a teletriage service. Brazilian Journal of Development. 2021.	Research and contextualize the experiences established during nursing practices in the Screening Service, entitled TELECOVID.	Experience report of nursing students in the development of the curricular internship, which took place from April to July 2020.
CV02	PubMed	English	VENDRIK, J. et al. Ongoing Transcatheter Aortic Valve Implantation (TAVI) practice amidst a global COVID-19 crisis: nurse-led analgesia for transfemoral TAVI. Neth Heart J. 2020.	Aim to show the safety and feasibility of TF-TAVI with nurseled local analgesia, possibly eliminating the need for an anaesthesiologist to be present in the cath lab.	The study population comprised 90 patients treated with TF-TAVI, with local analgesia performed by our dedicated cath lab nurses. The patients had a mean age of 80 ± 5 years and 59% were male, with a predicted surgical risk of $2.2 \pm 0.9/3.1 \pm 2.4\%$ (Society of Thoracic Surgeons Predicted Risk of Mortality [STSPROM] score/EuroSCORE II), depicting a contemporary, lower-risk population.
CV03	PubMed	English	RUSSO, Vincenzo. et al., Nursing Teleconsultation for the Outpatient Management of Patients with Cardiovascular Disease during COVID-19 Pandemic.	The aim of our study was to describe the medical interventions following nursing teleconsultation for the outpatient management of patients with cardiovascular diseases during the COVID-19 pandemic.	All patients who did not attend the follow-up visit were rescheduled due to the COVID-19 block. These were selected to be included in the study. Each patient was accompanied by a semi-structured telephone interview conducted by a nurse. The results of the study show good adherence of patients to the nursing teleconsultation and the usefulness of this tool to detect clinical conditions that require medical intervention.
CV04	PubMed	English	VALDEZ-LOWE, Claudia; PARIKH, Sachin; KENEL, Kristina L. Running a cardiology consult service during a pandemic: Experiences from the front lines. Journal of the American Association of Nurse Practitioners. 2021.	Running a cardiology consultation service during a pandemic: Frontline experiences.	Brief Report

Source: Research protocol, 2021.

Table 2: Evidence from the studies.

Nº	Evidence
CV01	During the call centers, the role of the nursing team in the prevention and control of comorbidities of vascular origin was observed, which were associated with more expressive cases of COVID-19. Still, in view of the implications of the virus, studies show that it acts causing inferences in systemic blood pressure homeostasis; in the pathophysiology of cardiorespiratory failure and also favoring intracellular inflammatory reactions. Thus, it can cause myocardial lesions, predispose the development of venous and arterial thromboembolism and activate the coagulation cascade, thus emerging cardiac disorders as one of the most serious implications given its poor prognosis. Finally, it was concluded that nursing practices added knowledge beyond assistance, given the constant exercise of clinical thinking, with which it was possible to relate to cardiac comorbidities the imminent risk of developing the most serious manifestations of SARS-CoV- two.
CV02	The composite endpoint of device success (Valve Academic Research Consortium [VARC]-2) was reached in all patients. No patients showed more than mild paravalvular leakage (3/90, 3.3%). Overall, intravenous medication was sparsely used during the procedure, with 48 of the 90 (53%) patients receiving no unplanned intravenous medication. There was neither procedural nor inhospital mortality. The performance of TF-TAVI using local analgesia only, managed by a dedicated nurse instead of an anaesthesiologist, was shown to be feasible and safe in a selected group of patients. This strategy may (temporarily) eliminate the need for an anaesthesiologist to be present in the cath lab and enables ongoing TAVI treatment amidst the global COVID-19 crisis.
CV03	In total, 203 patients (81%) underwent nursing teleconsultation in a mean time of 7.3 days from the outpatient visit lost due to the COVID-19 lockdown. Furthermore, 53 patients (26%) showed poor adherence to nursing teleconsultation. Among the 150 patients (mean age 67.10 years; 68% male) who completed the telephonic interview, the nursing teleconsultation revealed the need of medical intervention in 69 patients (46%), who were more likely at very high cardiovascular risk (77% vs. 48%; $p < 0.0003$) and who showed a higher prevalence of dyslipidemia (97% vs. 64%; $p < 0.0001$) and coronary artery disease (75% vs. 48%, $p < 0.0008$) compared to those not in need of any intervention. The up-titration of the lipid-lowering drugs ($n = 32$, 74%) was the most frequent medical intervention following the nursing teleconsultation. The mean time between the nursing teleconsultation and the date of the rescheduled in-person follow-up visit was 164.36 days. Conclusions: Nursing teleconsultation is a simple and well-tolerated strategy that ensures the continuity of care and outpatient management for patients with cardiovascular diseases during the COVID-19 pandemic.
CV04	It approaches that the assisting nurses had a fundamental role in the management of the cardiology health services at the peak of the pandemic due to COVID-19, since they contributed to the change in the profile of the health services attendance, making adaptations to receive the patients, as for example, the suspension of elective surgeries and surgical centers became exclusive units to assist COVID-19.

Source: Research protocol, 2021.

Category 1: Nursing care through teleconsultation to cardiac patients in the context of the COVID-19 pandemic

The literature analysis showed that in this current pandemic context, it was necessary to implement strategies to assist the population, such as the Telehealth Centers, which aim to provide remote assistance to those with signs and symptoms suggestive of COVID-19, in order to prevent the spread of the virus, the advancement of expressive clinical conditions, as well as the overcrowding of health units. [18]

During the consultations, it was observed that many patients had several associated comorbidities, among which stand out Systemic Arterial Hypertension, Acute

Myocardial Infarction, peripheral vascular impairment, ischemic stroke, Diabetes Mellitus and obesity. In general, a great relationship between pre-existing vascular disorders and more pronounced COVID-19 conditions was identified, going according to several scientific publications that refer to an unfavorable prognosis in the face of this association. [18]

Some authors suggest that the mechanism of entry of the new coronavirus occurs from its connection with the transmembrane angiotensin-converting enzyme (ECA2), which functions as a receptor. After its entry and subsequent replication in the human cell, the virus favors a decrease in the expression of ACE2, causing inferences in systemic arterial pressure homeostasis and in the

pathophysiology of cardiorespiratory failure. This loss of function causes less conversion of angiotensin II into angiotensin and, consequently, its greater availability in the body, which when bound to the AT1 receptor has pro-inflammatory and vasoconstrictor effects. Furthermore, the inactivation of ECA2 prevents its anti-inflammatory, vasodilatory, anti-fibrogenic and anti-proliferative protective effects from being manifested. Furthermore, it is estimated that in addition to these changes, there is an increase in the production of reactive oxygen species through the activation of NADPH oxidase 2, an enzyme complex linked to the membrane, which favors intracellular inflammatory reactions. [18]

The new coronavirus can also cause myocardial lesions and myocarditis, intensifying the clinical picture of those with previous heart diseases. Thus, the indiscriminate attack of the immune system, generates a storm of cytokines, a mechanism that is currently being discussed, where this exaggerated reaction in many organs, including the heart, has the consequence of elevating its enzymes (troponin I and NT-pro BNP). [18]

The prolonged inflammatory response, associated with decreased physical activity, the reduction in the amount of circulating oxygen, the presence of antiphospholipid antibodies and the lupus anticoagulant has been related to a predisposition to venous and arterial thromboembolism, as well as to the hypothesis of thrombo inflammation. In addition, it is further emphasized that the virus itself could activate the coagulation cascade, thus emerging venous and arterial thromboembolism and other cardiac complications as one of the most serious and prognostic implications with the worst results. [18]

In this way, the practices at the Triage Center allow nursing students to add knowledge beyond the care practice, when applying remotely, the exercise of clinical thinking. In this way, it was possible to correlate the scientific aspects studied with the observations evidenced during the call centers, which affirm to those with cardiac comorbidities the imminent risk of developing serious clinical manifestations of SARS-CoV-2. [18]

Finally, nursing practices at the Triage Center add knowledge beyond assistance, given the constant exercise of clinical thinking, with which it is possible to relate to cardiac comorbidities the imminent risk of developing the most serious manifestations of SARS-CoV-2. [18]

In Italy, teleconsultation is a method of providing health services through the use of innovative technologies in situations where the health professional and the patient are not in the same place. It involves the safe transmission of information and data in the form of texts, sounds, images or other forms necessary for the prevention,

diagnosis, treatment and subsequent monitoring of patients. Teleconsultation services must be equated with any diagnostic and / or therapeutic health service. However, telemedicine does not replace traditional health care, but integrates it to virtually improve efficacy, efficiency and adequacy. [19]

There are three different ways to provide these services: synchronous, asynchronous and remote. Synchronous refers to the delivery of health information in real time, through the use of digital devices, allowing a live discussion with the patient or provider to provide medical expertise. Asynchronous refers to the "store and forward" technique, while a patient or professional collects history, images and reports, then sends it to a specialist doctor for diagnosis and specialization in treatment. While the remote patient monitoring mode is obtained by means of an electronic device that records a continuous flow of information in real time about any patient that transmits data to a centralized website, which can be safely accessed by the healthcare team. [19]

During the COVID-19 pandemic, teleconsultation helped professionals to avoid direct physical contact and minimize the risk of transmission by SARS-CoV-2, decreasing morbidity and mortality for Covid-19 and, finally, providing ongoing care to the community. [19]

The strategy of replacing hospital visits with telecardiology has been effective in the short-term management of patients with cardiovascular diseases and patients prefer to continue with remote monitoring compared to the usual treatment. [19]

The nurse's involvement in telemedicine consisted of establishing an approach to collect anamnesis data or educating the patient in the detection of vital parameters, collecting laboratory and instrumental examinations performed. The findings of this study show that nursing in teleconsultation conducts semi-structured telephone interviews and electronic transmission of documents, having been a well-tolerated tool and accepted by 74% of the study population. [19]

In the future, to expand the use of the model of nursing care through teleconsultation and to increase its credibility with patients, it would be necessary to officially recognize the telemedicine service and address the evolving concerns related to reimbursement policies and health laws licensing. It is necessary to carry out support training for nursing interviewers, oriented to ensure clear and effective communication and standardized telephone follow-up. [19]

A national program for the digital literacy of the elderly should be created to increase adherence to nursing teleconsultation. All of these actions are mandatory to increase the use of telemedicine and mitigate interruptions

in care and improve the health of patients during the COVID-19 pandemic. [19]

The nursing teleconsultation revealed the need to optimize the monitoring of pharmacological therapy in about half of the study population. In particular, the lipid reduction titration and the adjustment of the oral anticoagulant dose were the most performed actions. [19]

This evidence supported the need for continuity of care and outpatient management for patients at high risk for cardiovascular disease during the COVID-19 pandemic. It was found that 62% of the study population did not reach the therapeutic goal of LDL cholesterol in relation to their cardiovascular risk profile. In particular, in 74% of cases, it was necessary to increase the titration dose of the lipid-lowering drug, confirming the suboptimal control of LDL among European patients at high risk of cardiovascular disease. [19]

The global approach to cardiovascular risk should be focused on lifestyle optimization (stop smoking, diet, exercise and weight loss), LDL reduction therapy and treatment of atherogenic dyslipidemia. Considering the worrying reduction in hospitalizations for acute myocardial infarction and the parallel increase in mortality rates and complications observed in Italy, careful management of residual cardiovascular risk is of fundamental importance for the general population during the COVID-19 pandemic. [19]

Cardiovascular prevention requires modern preventive cardiology programs delivered by interdisciplinary teams of health professionals that address all aspects of lifestyle and risk factor management to reduce the risk of recurrent cardiovascular events. [19]

The nursing teleconsultation revealed the need to adjust the dose of oral anticoagulant; in most cases (65%), an inadequately low dose level of New Oral Anticoagulants (NOAC) was found. The association between Direct Oral Anticoagulants (DOACs) and inadequate low dosage was explained by doctors' fear of hemorrhagic events or by therapeutic inertia at follow-up. [19]

NOAC underdosing was associated with an increased risk of thromboembolic events; consequently, it is of fundamental importance to prescribe an appropriate dosage, based on the Summary of Product Characteristics (SPC), in order to obtain a real world environment the same benefits demonstrated in randomized clinical studies. [19]

In the remaining cases (35%), the nursing teleconsultation revealed the need for a reduction in the standard dose due to a worsening of renal function. Although the impact on renal function is less for NOACs

than for Vitamin K Antagonists (AVKs), the assessment of creatinine glomerular filtration rate according to Cockcroft-Gault should be performed for the early detection of a common cause of reduction dose. [19]

These data confirm that the pre-specified follow-up schedule for patients using anticoagulant therapy should not be missed during the COVID-19 pandemic, particularly for elderly people with high cardiovascular risk and prevalent comorbidities, such as dyslipidemia and ischemic heart disease. [19]

Although NOACs are safer than AVKs in some different clinical settings, an inadequate dose can predispose to both thrombotic events. Furthermore, the use of any anticoagulant is associated with some drug interactions, which may increase the risk of severe bleeding or decrease protection against stroke. Teleconsultation should be oriented to evaluate blood collection (including hemoglobin, renal and hepatic function), check adherence and reassess whether the chosen NOAC or its dose is the best for the patient, according to age, weight or renal function. [19]

However, the nursing teleconsultation significantly anticipated the optimization of pharmacological treatment for about 4 months in comparison with the rescheduling of the face-to-face visit. Considering that the benefit of reducing LDL cholesterol depends on the timing and magnitude of LDL reduction, the strategy for implementing a successful early intervention can improve the health of the population and undoubtedly provide socioeconomic benefits, avoiding complications Expensive Atherosclerotic Cardiovascular Disease ASCVD. [19]

Category 2: Nursing care in the cardiac complications of COVID-19

Transcatheter Aortic Valve Implantation (TAVI) is a well-established treatment for aortic valve stenosis that has been widely adopted and has evolved into a minimalist and relatively low-risk procedure for most patients. Using only local analgesia, instead of conscious sedation or general anesthesia, it minimizes the invasive nature of the procedure and shows a decrease in the incidence of postoperative delirium and decreases the duration of hospitalization. If left untreated, the symptomatic of severe aortic stenosis has a poor prognosis. [20]

The current COVID-19 crisis has led to an unavailability of anesthetic support for non-acute cardiac care. In current practice, transfemoral (TF) TAVI is predominantly performed as an elective procedure in the catheterization laboratory. Thus, TAVI is an indispensable procedure that cannot be interrupted in the midst of the COVID-19 crisis. Through this study, the safety and viability of TF-TAVI performed by nurses through local

analgesia was demonstrated, possibly eliminating the need for an anesthesiologist present in the catheterization laboratory. [20]

However, the nursing program should preferably be started with a good risk for evaluation, training, planning and evaluation. The procedures were performed in a tertiary cardiac center with extensive experience and with all the necessary equipment (such as echocardiography machine and peripheral devices for left ventricular support), experienced staff and an operating room available on demand. [20]

TF-TAVI with analgesia conducted by nurses will evidently facilitate the planning of procedures in a more agile way, thus shortening the potentially dangerous waiting list for the procedure in regular clinical care. During the global crisis of COVID-19, this strategy can allow continuous treatment of TAVI and therefore can prevent deaths unrelated to COVID-19. On the other hand, hospitalization of frail elderly patients with TAVI may present an increased risk of COVID-19 infection. Thus, careful patient selection is necessary, considering the change in the risk-benefit ratio in the current pandemic. Mentias et al., (2020) [21] proposed an algorithm for the TAVI time based on the patients' health status and following the urgency of the procedure, which could be used as a guideline in these unusual times. [20]

Category 3: Nursing management in a cardiology unit in the context of the COVID-19 pandemic

The assisting nurses had a fundamental role in the management of cardiology health services at the height of the pandemic due to COVID-19, since they contributed to the change in the profile of health services attendance, making adaptations to receive patients, such as the suspension of elective surgeries and surgical centers have become exclusive units to assist COVID-19. [22]

It reports the experience of nurses in a Cardiology hospital in Detroit, Michigan-USA, in which they were protagonists in the control of mechanical ventilators, which were increasingly in demand, infusion pumps that were connected to long extension cables and if in the corridors outside the patients' rooms, the protocols were updated daily, changes in the structure of the hospitals in order to reorder the flow of entries and exits, mandatory screening was initiated, among other changes. [22]

In addition, they work on guiding the requirement to maintain a safe environment for staff and patients; they manage the teleconsultation service, in which most of the contact for patient admission was made by telephone; collect patient history by reviewing graphics and reviewing imaging studies, laboratory tests, telemetry, electrocardiograms and external records, when available;

manage the electronic medical record that documents how and why information about the history and physical examination was obtained. [22]

The medical and nursing staff became providers of social support for family members. They operate in a variety of environments and one of the most frequently identified attributes was the presence in clinical environments where there was a regular turnover of personnel. [22]

The continuity of nursing care provides the cardiology team with subsidies for decision making in search of the best conducts. Furthermore, the nurses' practices in the hospital allow independence from the management of routine cardiac problems. The nurse is also the readily available resource person who can quickly provide clinical guidance to other health care providers and assist patients with follow-up care. [22]

Numerous studies have shown that nurses who work in cardiology centers provide quality care, including specialized care services. The knowledge and experience that nurses have, often places them at the forefront of rapid changes as a result of the pandemic. Therefore, adaptability was identified as one of the primary characteristics for carrying out tasks during this pandemic. [22]

Furthermore, all providers of advanced practice within the cardiology division took turns being redistributed to care for COVID-19 patients in the cardiac units. [22]

As suggestions, he points out that health institutions should foster an organizational culture of resilience using three strategic principles. First, leadership, which must be focused on creating an environment of resilience, providing an optimistic and realistic action plan, in addition to providing frequent and open communication with staff. They recommend that the workload and any incentives be distributed equally to include all suppliers and support staff to avoid creating an environment of resentment and anger rather than building one of resilience. [22]

Second, the communication on COVID-19 must be updated and structured in a format that makes the employee feel empowered and not exalted with anxiety. The news is crucial to day-to-day operations in a pandemic, but the new changes should not make the employee feel like they are being bombarded with a lot of information. A specific institutional page where information is regularly updated with news and information resources would reduce the feeling of being overwhelmed. [22]

Third, providing continuous mental health support to nurses is necessary to preserve their well-being and consequently their productivity at work. [22]

IV. CONCLUSION

From this study, it was possible to understand about the main nursing care that should be provided in cardiovascular complications associated with COVID-19, with regard to its activities in monitoring patients in teleconsultation, nursing care in COVID-19 cardiological complications, such as the TAVI procedure and the management of the nursing service in a cardiology unit in the context of the pandemic COVID-19.

It is concluded that nurses have been facing great challenges in relation to the care of patients with cardiovascular diseases, as they are a high-risk group and have a greater susceptibility when presenting the severe forms of COVID-19. The pandemic highlighted the essential role of these health professionals who provide care to protect people's health and save lives.

Finally, nurses have a wide field of action in the front line when dealing with a new disease that has been showing successive mutations with constant changes in its epidemiological pattern. The losses of COVID-19 to the cardiovascular system are present in the short and long term and it is up to nurses to play an important role in the prevention, diagnosis, monitoring, treatment and rehabilitation of heart diseases.

From the results of this study, it is suggested to carry out fieldwork in order to identify the role of nurses in cardiology in the context of the pandemic in different health care scenarios.

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Assessment of Water quality For Balneability of Francisquinha Stream - Porto Nacional – TO

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Keywords—*Bathing, water quality, total coliforms and Escherichia coli (E. coli).*

Abstract—*The search for areas for recreation, directs people to subject themselves to bathing places with probable contamination, caused by sewage residues, concentrations of garbage among countless others that cause, the appearance of bacteria such as total coliforms and Escherichia coli (E. coli). Microbiological analyzes were performed using indicators of total coliforms and Escherichia coli (E. coli), according to the method described by APHA (2005). The study sought to assess the water conditions of the Francisquinha stream hydrographic basin in the municipality of Porto Nacional - TO, for bathing purposes, according to CONAMA Resolution 274/2000. Using the parameters to detect and identify the presence of total coliforms and Escherichia coli, the Colilert technique was used. The results presented Escherichia coli were low, adapting in the classification of own bathing, according to CONAMA Resolution 274/2000. With the data presented in the study, during the analyzed period of six weeks, the results were satisfactory for recreation of primary use of the Francisquinha stream watershed.*

I. INTRODUCTION

Water is indispensable for human existence. Water is of great importance to the economic and social sectors, since it is used for various activities. It generates a demand for good quality water, which is able to meet demands, such as domestic use, irrigation, animal and plant care, industrial supply, species breeding, power generation, navigation, landscaping, waste dilution, recreation and leisure (NETO, 2006).

Due to the use of water for recreation, it is of utmost importance for individuals due to the growing increase in bathers, and thus can generate certain risks and damage to health. It may contain some types of contamination by various types of waste, such as sewage or garbage that are carried by rain or that are dumped directly into the river (BENETTI & BIDONE, 2001).

According to Silva et al. (2013), there are numerous other pollutants such as in the atmosphere or in the soil.

There is also the application of toxic products in agriculture, which can reach the water, and end up depositing pathogenic microorganisms and toxic elements. These factors can cause unbalance in the aquatic environment, which consequently generates various health risks for the users.

The use of water for recreation is significant for people, since there is a great use of bathers, so it can generate health risks, because it can contain some kind of contamination by sewage or garbage that ends up being carried by rain or that is dumped in the river. There are pollutants that exist in the atmosphere or in the soil, from the application of toxic products in agriculture, which, when brought near the water, deposit pathogenic microorganisms and toxic elements. Thus, they generate unbalance in the aquatic environment, posing risks to the health of users, according to the CONAMA Resolution 274/00.

With the construction of the Luís Eduardo Magalhães Hydroelectric Power Station, in the municipality of Lajeado - TO, on the Tocantins River. It generated a lake, damming water and thus raising the water level, thus submerging the riparian forest, beaches and buildings located on the banks of the lake. As a result, the quality of the water for recreational use has deteriorated.

According to CONAMA Resolution 274/00, fresh, brackish, and salt waters will have their quality levels evaluated by specific assessments, so as to certify bathing conditions (primary contact recreation such as diving, swimming, water skiing, and sport fishing). Through this study, the Probable Number (MPN/100ml of water) of the fecal coliform group (thermotolerant) and *Escherichia coli* (E. Coli) present in the waters of the Tocantins River basin, Francisquinha stream, were determined.

This study aimed to evaluate the water conditions of the Francisquinha stream watershed in the municipality of Porto Nacional - TO, for bathing purposes, according to CONAMA Resolution 274/2000.

II. MATERIALS AND METHODS

STUDY AREA

With the help of a GPS - Global Positioning System, the point of collection was determined where it was easily accessible and could be checked in order to obtain an accurate analysis of the location.

The Francisquinha Stream Basin area is located in the state of Tocantins, in the municipality of Porto Nacional, which is located in the geographical center of the state, in the eastern mesoregion, with an average altitude of 212 meters above sea level, with a surface area of 4,449.9 km² and coordinates 10°42'29" latitude and 48°25'02" west longitude.

Two types of tests were performed, the fecal coliform and the pH test. The fecal coliform test confirms the presence and number of bacteria originating from waste in the water sample. Because bacteria can cause transmission of diseases such as hepatitis or cause intestinal gastric problems (INMETRO, 2018).

The research was not conducted during the beach period, which is from June to July, when there is a high concentration of people, which could hinder the course of the study, the samples collected, thus hindering the final results.

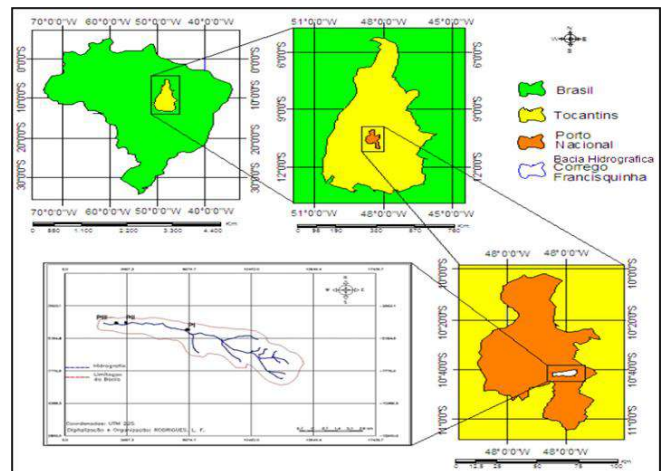


Fig.1: Map of Francisquinha Stream location

Fonte: RODRIGUES (2016)

The COLILERT technique was used to determine the Most Probable Number (MPN/100ml) of fecal coliform bacteria in 100 ml of water, in accordance with the methodology of the Standard Methods for the Examination of Water and Wastewater - APHA, 2005/American Public Health Association.

In this context, laboratory results were found in accordance with the parameters for water quality according to CONAMA Resolution No. 274/00, which establishes the conditions for bathing, which are classified as suitable or unsuitable for primary contact recreation. The confirmation of high fecal coliform values will indicate fecal contamination of the water, which can cause risk to the bather's health.

Therefore, the analysis of the water of the Francisquinha stream was guided by sample collection, laboratory analysis, correlation with legislation and other parameters pertinent to the evaluation of water for recreational use.

III. METHODOLOGICAL PROCEDURES

For the research, the procedures of "on-site" sample collection and laboratory analysis were used.

Sample Collection

The sampling took place in the period between February and March 2021, after the selection of some main points. The water was collected about 25 cm below the water surface, using sterilized and identified bottles with a capacity of 100 ml, a considerable quantity for the analysis. As stated in article 5 of the single clause of Conama Resolution 274/2000, the collection site was determined where there would be a greater accumulation of bathers.

After the collection of the bottles, they were sealed and stored in an isothermal box properly refrigerated and taken to the Physical-Chemical Laboratory of the IFTO - Federal Institute of Tocantins in Porto Nacional - TO, where several analyses were performed to define the absolute concentration of total coliforms and *E. coli*, according to the method described by APHA (2005). It was also used the parameter of physical and chemical analysis of the pH of the water.

Microbiological analysis

Through the use of the Coli-ert method, microbiological analyses were performed in the waters of the Francisquinha stream, analyzing them according to the method described by Standard Methods (APHA, 2005). The method is related to the recognition of bacteria from the group of total coliforms and *E. coli* considering a 24-hour period.

The use of the Colilert method considers the Colilert enzyme in the amount sufficient for the evaluation of 100 ml of water; each enzyme was added to 100ml in the bottle of the sample in question collected and stirred until the granules were fully diluted. Soon after, the solution was incubated in a laboratory oven at 35°C for 24 hours.

To define the analysis results, it is noteworthy that if the medium remains colorless, it indicates that there are no total coliforms and *Escherichia coli* bacteria in the samples. If the medium turns light yellow and fluorescent under ultraviolet light, it indicates the presence of bacteria of the total coliform group in the samples being analyzed, according to Marquezi (2010).

After obtaining the laboratory results, they were compared with the values established in CONAMA Resolution 274/00, in order to classify the bathing water as suitable (excellent, very good and satisfactory) or unsuitable, according to the density of *E. coli* bacteria.

IV. RESULTS AND DISCUSSION

According to the monitoring that occurred during the months of February and March 2021, which is the rainy period in the state, the volume of the stream ended up increasing, which caused the water in the study to have a dark coloration, due to the solids carried to the riverbed.

Several bacteria can be found in rainy periods, since the water suffers a great movement among the soil, which ends up carrying several impurities to the riverbed, and solid waste can be found, such as animal feces or even toxic matter, which compromises the quality and safety of the water for bathers (GOULART and CALLISTO, 2003).

According to Smith et al. (1995), it is important to inform bathers that the quality of water is not based on its color, since water with a transparent color can have a risk factor, because it may be contaminated with pathogenic microorganisms from fecal pollution sources.

During the execution of the Total Coliforms and pH test to assess the presence and number of bacteria originating from waste, the samples from the six weeks of the study showed an average pH of 6.87, and total coliforms per 100 ml a value of 79.4, i.e., what fits the waters of the Francisquinha stream as suitable for bathing purposes of primary contact.

According to SILVA, LIMA, and BALDUINO (2019), reports in a study conducted under the same conditions at the Beira Rio Beach in Porto Nacional, presented an average pH similar to that found in this study, which can be explained by the fact that the collection of samples was done in a rainy period, thus with the runoff of rainwater possibly contaminated by waste and animal feces or the presence of nearby sewage.

According to Vieira (2015), the processes corresponding to the supply and treatment of wastewater, pH can affect several of the chemical and biological processes of water. It can influence several factors, such as dissolved gases and solids, alkalinity and hardness, temperature and biotic factors. The pH can vary between 0 and 14 (very acid to very alkaline), as there is a factor of interference in the metabolism of species.

CONAMA states that through resolution 274/00 where the values found should remain between 6 and 9 (ANA, 2020). In the studies, an average of 6.87 was obtained, fitting the range stipulated by CONAMA Resolution 274/00. Throughout the period, the pH obtained some oscillations, but remained within the existing range according to Resolution CONAMA 274/00, which indicates pH values around 6.0 to 9.0 for springs. The average value indicated is slightly acidic.

With the results obtained, it was noted that the water from Francisquinha stream is safe according to the parameters, thus making it fit as a category suitable for primary contact bathing purposes.

As the point evaluated by the study does not contain any type of basic devices to inform bathers about the quality of the water, this study may arouse the interest of public agencies to adapt and carry out frequent monitoring at the site, as the bathing conditions vary with time and use, making its evaluation indispensable.

V. CONCLUSION

According to the CONAMA Resolution 274/00 (BRASIL, 2000) states, bathing can be defined as: the condition of saline, fresh and brackish waters, which are used for primary contact recreation, known as by direct and prolonged contact with water (diving, swimming, water sports, etc.), where there may be the possibility of ingesting large quantities of water.

The study carried out in the Francisquinha Stream is of great relevance, since it gives information about the real state of the water. The classification of the water was given as suitable for primary contact recreation, presenting excellent qualities, since in all the samples analyzed, none obtained values for E. Coli above 200 NMP/100 ml and did not present pH values outside the standards.

According to the results, it is expected to awaken an interest for a frequent monitoring by the public organs and the population, thus ensuring an adequate control for bathing, stimulating the use of the stream throughout the year as a place dedicated to the practice of recreation and leisure, according to the criteria established by CONAMA Resolution 274/2000.

Attention is needed from the population and from the agencies, because of the residues that are common to be found, such as bottles, cans, human hair, cardboard boxes, bags, cigarette butts, food waste, discarded clothes, human and animal excrement, and paper. To ensure that it provides a clean and contamination-free environment for local users.

Due to this fact, periodic inspection is necessary, a good job of cleaning the river banks and the residues, to keep them away from being carried to the water during the rainy season. Also the supervision of commercial establishments, residences and others, requiring an adequate treatment of domestic wastewater.

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The importance of the ITIL framework in managing Information and Communication Technology services

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Keywords— *Best practices, framework, ICT, ITIL, ICT services.*

Abstract— *Nowadays, whether within the corporate or academic environment, it is practically impossible to conceive professional activities without the support of Information and Communication Technologies (ICT), and it is rare to find a place where ICT is not present. In this context, over the years a variety of management frameworks have emerged or improved, which incorporate digital technologies in their methodologies. However, these frameworks aim to demonstrate a series of conducts and procedures, previously tested, based on the best corporate practices of reference companies in their areas of activity in the business environment, with the objective of applying the best management practices of ICT services and processes. The objective of this article is to demonstrate how the ITIL framework can potentially increase, qualitatively, the implementation of ICT services in professional environments.*

I. INTRODUCTION

ITIL is one of the most widely used frameworks for ICT service management [1], and guides any type of service provider, regardless of industry, demonstrating how to provide better quality ICT services efficiently and effectively. This framework acts and directly influences the processes, services, and functions of a company, supporting the management of ICT services provided to external and internal customers of companies, by demonstrating the necessary skills, to best achieve the desired goals in the digital management of the company's business.

The alignment of ICT with the company's business is a difficult and demanding role in terms of the capabilities of the technology area, whose main objective is to help the company achieve its objectives and goals [2].

The ITIL framework initially emerged as an acronym for "Information Technology Infrastructure Library", but currently it is only referenced as a brand, having more than thirty years of existence [3]. ITIL is not a rigid standard

that should be followed without adaptations to the specificities of the professional context of companies, but rather a guide that contains good practices that can be adopted and adapted to the reality of each organization, following its needs. Within the context presented so far, a question arises: Why manage ICT services?

Information management has a strategic value for companies' business rules [4]. Therefore, managing ICT services, help business processes to have greater efficiency and effectiveness in handling information, and also enable various types of business. For example, let's imagine some businesses, such as banks, airlines, e-commerce, and supermarkets, without making use of ICT. In these examples we observe that such businesses would be unfeasible to manage without the use of digital technologies, that is, these businesses are completely dependent on the use of ICT, and this has been a continuous concern in organizations [5].

Currently, much of the business processes are carried out through ICT resources, demonstrating how important

ICT is for the business operation and at the same time indicating that the interruption of services can be extremely negative because in most companies there is a constant growth in demand for ICT services [6], often in counterpoint to the preparation of the technology areas, to provide adequate services, on time, and with desirable quality. Therefore, a detailed study of the types of ICT services in an organization is fundamental, as well as their constant monitoring. We will demonstrate in this article, through the use of the ITIL framework, how it can be an important ally in the task of improving ICT processes and services in an organization, and in supporting management.

II. MANAGEMENT OF ICT SERVICES AND PROCESSES

Before discussing the ITIL methodology for ICT service and process management, it is necessary to define what a service is, i.e. a means of delivering value to internal and external customers, facilitating the results they want to achieve while striving to reduce risks and costs [7]. In this paper, we will specifically deal with ICT services and processes, which are provided by so-called service providers.

The ICT service is composed of a junction of three primary factors that are: technologies, people, and processes [8], but when we refer to customers, they view the service as a single entity, that is, they do not view all the processes involved in the provision and maintenance of the service used, in this case specifically is that ITIL acts improving these processes, making them more efficient through the improvement of existing processes, or through the creation of new processes. But it is important to note that ITIL also acts on the people, their roles, and functions in the organizations, who are involved with these processes at various levels, enforcing the "tripod" that defines the ICT service mentioned above.

Once defined what the ICT service is about, service management is related to a set of organizational skills [1] [9], aimed at providing value to customers in the form of services, such organizational skills consist of management practices, processes, functions, roles, knowledge, and skills that a provider uses, to deliver services with quality, efficiency, and effectiveness. Proper service management makes it possible for a provider to observe clearly, how services are being delivered, visualizing whether they expectedly meet the customers' needs.

ITIL describes three essential types of ICT service providers [3], as, 1. Internal service providers: located within the company itself, the scope of a business unit, and there may be several providers within a company, 2.

External service providers: technology companies that provide ICT services to companies contracting these services and, 3. Shared providers: autonomous service units, which provide ICT services to two or more business units, within a corporate matrix.

Regardless of the type of provider and the type of customer (internal or external) the ITIL framework can be implemented in all services and processes, improving service quality within the organization itself, as in services provided to third parties, deploying it even with other frameworks such as [10].

ITIL classifies ICT services into three types, a classification that is linked to the relationship of customers with these services, they are: Core services: responsible for delivering solutions and value to one or more customers, adjusted to the need and cost that the customer is willing to pay, being services provided continuously and with the need for a high degree of satisfaction; Support services (secondary): responsible for supporting the main services, so that they are delivered as agreed, usually not visible to customers, but which are fundamental in supporting the main service; Enhancing services: can be considered with additional functionality, which transcends the main service contracted to make it more interesting and attractive to the customer.

The ITIL structure is based on the management experiences of several companies that have been successful in the corporate market. In other words, ITIL is a structure that works with a high degree of organizational maturity, and when we refer to maturity, we mean that a certain organization has reached a very high level of efficiency and effectiveness in its processes. About efficiency and effectiveness, according to Peter Drucker [11] who is considered the father of modern management, efficiency is doing things right and effectiveness is doing the right things, and the result depends on doing the right things right, so to be successful in providing a service, ITIL suggests in its collection of books how to work more efficiently, designing a service using best practices, but for this to be possible, we have to raise the quality level of the intended service processes, and in this respect, ITIL provides an advantage in its structure, because we can adapt it to any business rule.

In this case, ITIL describes generic roles [3] that support the delivery of services with quality, dividing them into 1- Process owner: responsible for ensuring that a process is correct to its purpose, usually this role is assigned to the same person who performs the role of process manager, however, these two roles may be separated in larger organizations. The process owner has the responsibility to ensure that the process is carried out

according to a previously agreed and properly documented standard, in order to meet the objectives of the defined process itself; 2 - Process manager: responsible for the operational management of a process, in this case there may be several process managers for the same process in the organization, for example: ICT service continuity manager in several units of the organization; 3 - Process professional: responsible for performing one or more activities of the process, being that in smaller organizations it can be accumulated by the process manager himself; depending on the size of the organization one can have several process professionals, performing different activities; 4 - Service Owner: responsible for ensuring that the service is focused on the business and if the service is being delivered properly, this role should be unique and it is about who reports to an ICT Director, regarding the service delivery. It is worth noting that the same person can assume the role of an owner of several services, which usually occurs, as in the case of an ICT Project Manager.

III. THE PRACTICAL IMPLEMENTATION OF ITIL IN ENTERPRISE ENVIRONMENTS

When considering that companies are increasingly dependent on ICT services to perform business activities, it is necessary to properly plan the implementation of ITIL, in this sense Baz [12] propose a series of tasks included in phases, such as 1-Startup of the project, 2-Evaluation of the current situation of services, 3-Denition of processes to implement, 4-Implementation of process management tools, 5-Process implementation, 6-Evaluation and evolution of implemented processes.

Regardless of the methodology chosen or developed by companies to implement ICT services, it is important to emphasize what the latest version of ITIL refers to, that is, ITIL 4 and its new conceptual model that in general terms has some key elements [13], such as the Service Value System (SVS), the Service Value Chain (SVC), the four dimensions of service management, the guiding principles and ITIL practices.

In the SVS is the service value chain which is a flexible operating model for the creation, delivery, and continuous improvement of services. The service value chain defines six main activities [3]: Plan; Improve; Engage; Design and Transition; Obtain/Build; Deliver, and Support; Products, and Services, as we can see in Fig. 1[3]:

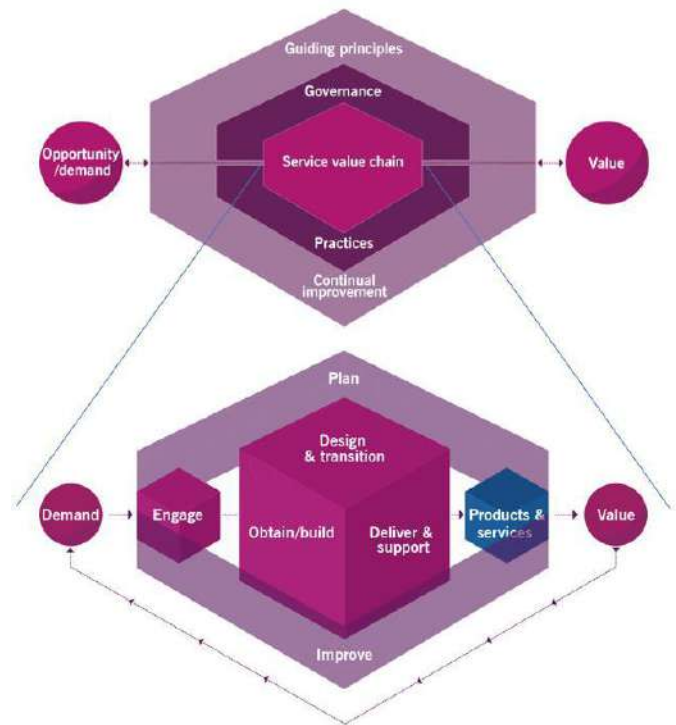


Fig. 1: The ITIL 4 Service Value System

In ITIL 4 a holistic approach is presented, divided into four dimensions that have as its central objective the value that a given ICT service provides to customers and project stakeholders, as we can see in Fig. 2[3]:

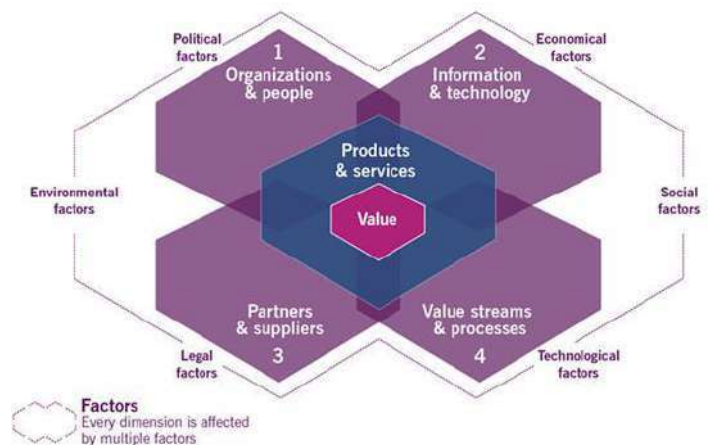


Fig. 2: ITIL 4 dimensions of IT service management

ITIL 4 indicates seven guiding principles. These principles are already known from previous versions of the framework and are intended to help companies adopt and adapt ITIL guidelines to their own specific needs and circumstances. The guiding principles are: Focus on value, Start where you are, Progress iteratively with feedback, Collaborate and promote visibility, Think and work holistically, Keep it simple and practical, Optimize and automate. However, the guiding principles must be

evaluated in all phases of implementing ICT service delivery. The ITIL 4 aspects of collaboration, automation, and simplicity reflect the values found in other frameworks such as Agile, DevOps, and Lean methodologies.

The ITIL framework seeks through its best practices to indicate an ICT management model focused on the customer and the value of the service provided. ITIL is a facilitator, which has a comprehensive structural model of processes that can be used according to business needs, i.e. it is not necessary to apply all the processes at once, but those that meet the immediate needs of a particular company process, according to its size and number of services. The management procedures and processes organized by ITIL in its structure can provide a direction for the organization to follow in pursuit of its goals because as said before, ITIL is structured on the experiences of the best companies that work with ICT and business management. It is a management model that can be applied gradually because ITIL is not software, but a "good rule of conduct" that can assertively guide the organization that intends to adopt good practices in ICT service management, especially in coherent dialogue with the organization's governance, which generally sees ICT as an area that generates large costs, which is true to some extent, but if worked on assertively, it can also generate a huge indirect profit for the company and increase the level of quality of the ICT services provided to internal and external customers.

IV. CONCLUSION

ITIL allows the organization, in this case, governance, to have a better view of the importance of ICT in the company, adjusting the relationship of the various departments, i.e. internal customers, and especially in decision making to meet the needs of external customers, regardless of technology, because ITIL is a non-proprietary model, widely tested, and used in leading organizations in the world, in any area of activity.

In conclusion of this article, if used properly, the ITIL framework is very important for the management of ICT services, individually or together with other frameworks, because it provides proven results for the business, such as reduction in the execution time of processes, or execution in an adequate time, strengthening of control and monitoring, mainly through the metrics that the framework indicates, a notorious elevation in the degree of satisfaction of internal and external clients, reduction in costs with ICT, either in the infrastructure or with qualified personnel, given the appropriate study of the real needs of the business around ICT services, reduction of unavailability of ICT resources, caused mainly by the

failure of planning and study of needs, increased recognition by the governance of the company, which starts to see ICT as a strategic point and primary area in achieving the business objectives of the company.

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Preliminary Experimental Study of a Single Slope-Double Effect Solar Still Incorporating a Phase Change Material

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Keywords— Double Effect, Evaluation,
Experiment, Performance, Single
Slope, Solar Still.

Abstract— The performance of a double effect solar distillation unit incorporating a paraffin wax has been studied experimentally under the climatic conditions of Owerri, South-East Nigeria. The system comprises double basins with an absorber area of 1.10m² and a saline water storage tank. It was positioned in the North-South direction with both upper and lower glazings inclined at the latitude of the study location. Performance evaluation of the system was conducted for an extended period of time, capturing both diurnal and nocturnal phases of the system's operation. The hourly distillate yields of the upper and lower basins were compared. The lower basin performed better than the upper basin during diurnal phase. The diurnal distillate yield of the system ranged from 0.415L to 0.741L for the lower basin and zero to 0.025L for the upper basin. The system achieved a maximum distillate yield rate of 0.21 L/h and an average efficiency of 11.71%.

I. INTRODUCTION

Rises in global mean air temperatures, ocean temperatures and sea levels are evidences of global climate change. This has led to the reduction in available freshwater quantity and thus, there is need to improve environmentally friendly ways of producing freshwater. The act of collecting dew to produce freshwater is probably as old as humanity. The ancient Greek sailors in the 4th century B.C., were said to have produced freshwater from the evaporation of seawater [1]. Desalination technology was used during the Second World War to produce potable water from brackish water due to the acute scarcity of freshwater [2]. Desalination process involves the removal of microbes, salt and other dissolved substances from saline water. During a desalination process, saline water is introduced into a process equipment and energy in the form of heat, pressure or electricity is applied, to produce desalinated water and concentrated brine [3]. Desalination processes can be grouped into two distinct categories,

namely, phase change process (thermal driven) and single-phase process (membrane separation). In phase change process, heat is utilized to evaporate saline water, which later condenses to produce freshwater. In single-phase process, membrane is used in separation of freshwater from saline water [4]. Solar energy serves as an important energy source especially in rural areas without access to grid electricity supply, albeit with low efficiency. Solar thermal distillation system comprises a solar heat collector and a distiller. If the heat is provided by a separate solar collector, it is known as indirect process. If all components are integrated into the distillation plant, it is referred to as direct process.

Conventional solar still was first introduced by Charles Wilson in 1872 in Chile [5]. The system was in operation for forty years. It had a total distillation area of 4,700m² and a production capacity of 4.9kg/m² [6]. Ugwuoke et al. [7] conducted a performance evaluation of a solar water purifier made with glass fiber structure. The solar still was

tested at Nsukka, Nigeria from November 2013 to December 2013. The maximum and minimum distillate yields recorded on the 4th day of the experiment were 1.1 liters at 14:00-16:00 hours and 0.2 liters at 08:00-10:00 hours respectively. Gan et al. [8] developed a novel solar distillation kit using a fiber rich paper coated with carbon black as its wick material. The system recorded efficiency of 88% and a production rate of $1.28\text{kg}(\text{m}^2\text{h})^{-1}$. Using transparent Perspex condensing cover and a reflective mirror of area 0.18m^2 , Eze et al. [9] constructed a solar still of 0.6m^2 absorber area for the purification of Lagos bar beach water. The system recorded a distillation efficiency of 36.8%. Ozuomba et al. [10] fabricated and tested a solar distillation kit in Owerri. The system recorded a mean daily production of 0.09m^3 for an absorber area of 0.16m^2 . Aburideh et al. [11] studied the performance of a double slope solar desalination unit with an absorber area of 1.39m^2 . The system recorded an average daily productivity of $4\text{L}/\text{m}^2$. The accumulation of dissolved particles left behind in the basin of a solar still during desalination leads to the corrosion of the absorber plate and serves as a performance inhibitor. In order to overcome this shortcoming, Umar et al. [12] examined a single slope solar distillation unit of an absorber area of 0.35m^2 ; modified with a 4-inch air tight hand hole at the side wall. Freshwater yields of $1.46\text{L}/\text{m}^2$ and $1.66\text{L}/\text{m}^2$ were recorded for the system with and without the modification respectively. However, the inclusion of the modification enabled the removal of the accumulated residues thus, minimizing basin corrosion.

Suneja et al. [13] compared the performances of a distillation unit having double basins but with the absorber inverted and another unit with normal absorber position. Observation showed that the unit with the absorber inverted performed better than the conventional unit. Madhlopa [14] investigated the performance of solar distillation system with triple basins, comprising an evaporation unit and two condensation units. The system recorded a total freshwater amount of $4.599\text{kg}/\text{m}^2$, as well as efficiency of 39%. This represented a performance improvement of 22% over a single basin solar still. Hashim [15] conducted a performance comparison of double and single basin solar distillation units and observed an improvement of 11% by the double basin type. The performance further improved by 32% with the addition of external reflectors. Nithin and Hraiharan [16] achieved a daily freshwater production of $5.2\text{kg}/\text{m}^2$ with a double basin solar still attached to a flat-plate solar collector. Ahmed et.al. [17] studied the performance of a three-stage evacuated solar distillation unit. At a pressure of 0.5bar, the system recorded daily freshwater yields of $6\text{kg}/\text{m}^2$, $4.3\text{kg}/\text{m}^2$ and $2\text{kg}/\text{m}^2$ for the first, second and third

stages, respectively. A marked reduction in production was observed with increase in pressure. Elsharif and Mahkamov [18] conducted a simulation of an evacuated multi-effect solar still with the aid of Matlab/Simulink. The system recorded freshwater yields of $39.9\text{kg}/\text{m}^2$ and $25.95\text{kg}/\text{m}^2$ at 0.03bar and atmospheric pressure respectively. Dutt et al. [19] observed that the flow of water at a low rate over the lower condensing surface of a double effect solar still improved the overall performance of the system. Al-Hinai et al. [20] evaluated the performances of single and double basin solar stills and observed an average annual distillate yields of $4.15\text{kg}/\text{m}^2$ and $6.1\text{kg}/\text{m}^2$ for the single and double basin stills respectively. Kumar et al. [21] conducted a configuration optimization of an evacuated multi-stage solar distillation system. Optimum performance of $28.04\text{kg}/\text{m}^2$ was found for a four-stage system. With an operating pressure of 0.03bar, the system recorded a maximum freshwater yield of $53.21\text{kg}/\text{m}^2$. In this study, a double effect solar distillation unit with a paraffin wax placed below the absorber plate was fabricated and tested in Owerri, Nigeria.

II. PRINCIPLE OF OPERATION

The energy exchange processes within and around the system is shown in Fig.1.

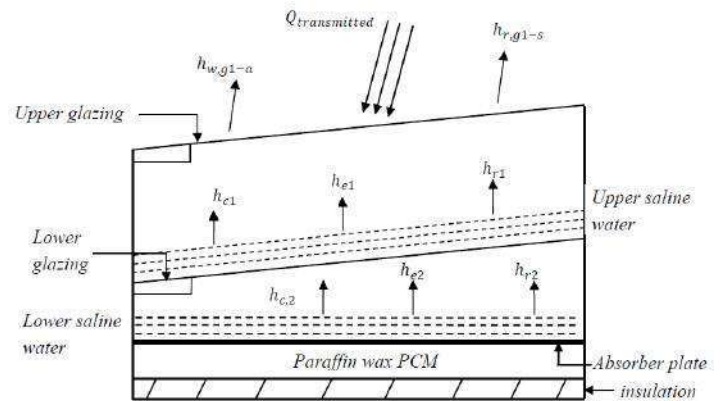


Fig.1: Energy exchange processes in a double effect solar still with a paraffin wax

The upper and lower glazings transmit the incident solar radiation to the absorber plate. The glazing system allows short wave radiation to pass through them but do not allow long wave radiation to go out, thereby acting as heat trap and as such, maximizing the absorber heat build-up. The absorbed thermal energy is transferred to the lower saline water and the paraffin wax below the absorber plate by convection and conduction respectively. The energy transferred to the lower saline water heats it thereby initiating evaporation. The air-vapour mixture rises to the

underside of the lower glazing by convection where the evaporated energy is lost due to condensation thus leaving behind microbes, salts and other dissolved substances that were in the saline water. The condensate aided by gravity, drips down the lower glazing and is collected in a measuring trough. The released latent energy at the lower glazing plus the absorbed radiant energy, heats the upper saline water thus, initiating evaporation at the interface. Similarly, the resulting vapour loses its latent energy at the underside of the upper glazing and gets condensed in the process. The condensate flows into a measuring trough at the lower end of the upper glazing. The energy gained by the upper glazing is lost to the environment by radiation and convection to the sky and the ambient air respectively. The paraffin wax below the absorber plate is utilized during off-sunshine hours as the energy source and its duration is a function of the available mass.

The efficiency of a solar distillation system is expressed as the ratio of the released latent energy to the absorbed solar irradiance [5] and it is expressed mathematically as:

$$\eta_i = \frac{\dot{m}_p h_{fg}}{GA} \quad (1)$$

Where \dot{m}_p is the rate of freshwater production, h_{fg} is the latent heat of vaporization of water per unit mass at the condensing surface, G is the solar irradiance flux and A is the area of the absorbing surface.

III. EXPERIMENTATION

3.1 SYSTEM DESCRIPTION

The system comprised upper basin, lower basin and a saline water feedstock tank. The saline water from the feedstock tank was fed into the upper and lower basins of the system through the connecting pipes regulated by valves as depicted in Fig.2.



Fig.2: Experimental setup of the double effect solar still with a paraffin wax underneath absorber

The upper glazing served as the condensing surface of the upper basin while the lower glazing served as both the base of the upper basin and the condensing surface of the lower basin. A 4kg paraffin wax placed below the absorber plate served as the phase change material. The lower and upper basins were housed inside a wooden box which served as insulation for the side walls and base of the solar still. The lower and upper glazings were inclined at the latitude of Owerri (N5.49°). The test rig was positioned in the north-south direction at the Mechanical Engineering Workshop, Federal University of Technology, Owerri. The design parameters of the double effect solar distillation system are shown in Table.1

Table.1. Design specification of the double effect solar distillation unit

Component	Specification
Top condensing cover	Transparent glass (low iron)
Base of upper basin	Transparent glass (low iron)
Base of lower basin	Black galvanized steel
Phase change material	4kg paraffin wax
Absorber area	1.10m ²
Breadth of basin	1m
Length of basin	1.1m
Thickness of glazing	3.2mm
Angle of inclination of the upper and lower glazing	5.49°

Combined front height of upper and lower basins	0.74m
Combined back height of upper and lower basins	0.836m

3.2 INSTRUMENTATION

The temperatures of the system components and the ambient air were measured using thermocouples. The thermocouples were linked to a data logger for automatic data capture while the system was in operation. The mean temperatures of the representative points of the components were captured and recorded on a memory card for an interval of five minutes. The recorded data were extracted from the data logger and transferred to a Microsoft excel worksheet. A Solar power meter with a measuring range of $0.1 \sim 1999.9 \text{ W/m}^2$ was used to measure the hourly solar irradiation on a horizontal surface at the test location. The surface wind speed was measured on an hourly basis with the aid of an anemometer placed at a height of 4m from the ground. The produced freshwater flowed through the outlet pipe to a measuring flask where the volume was measured and recorded. A schematic diagram of the thermocouple positions on the solar distillation unit is shown in Fig.3.

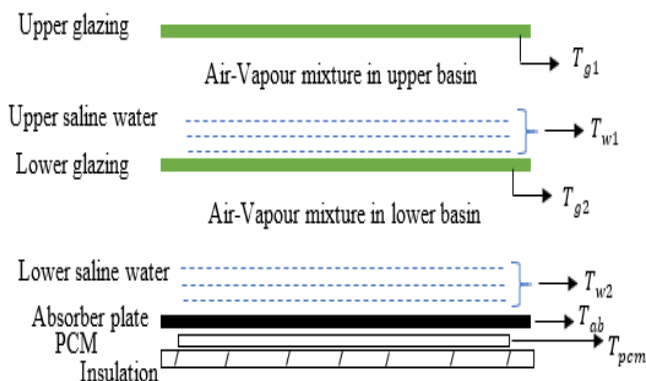


Fig.3: Positions of the thermocouples on the solar distillation unit

IV. RESULTS AND DISCUSSION

The results obtained from the experimental investigation for representative days of 28th January, 2nd March, 29th September and 10th October 2020 are presented in figures 4 to 13.

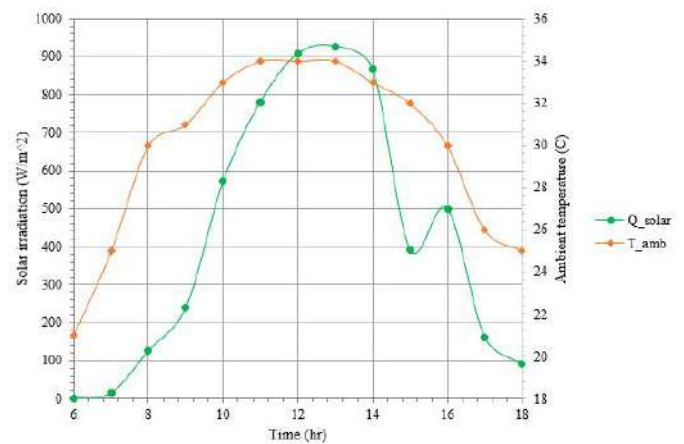


Fig.4: Solar irradiance vs ambient temperature in Owerri on 28th January, 2020

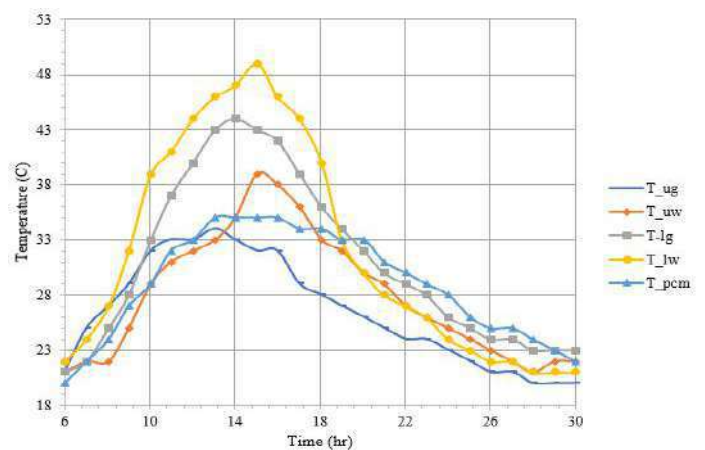


Fig.5: Twenty-four hours temperature profiles of the solar still components on 28th January, 2020

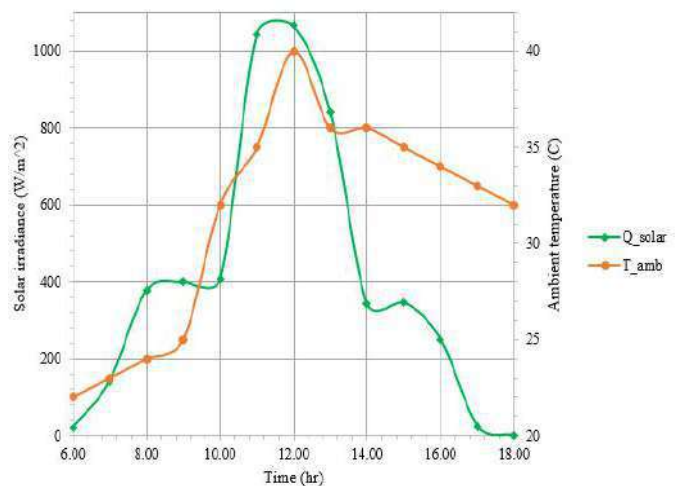


Fig.6: Solar irradiance vs ambient temperature in Owerri on 2nd March, 2020

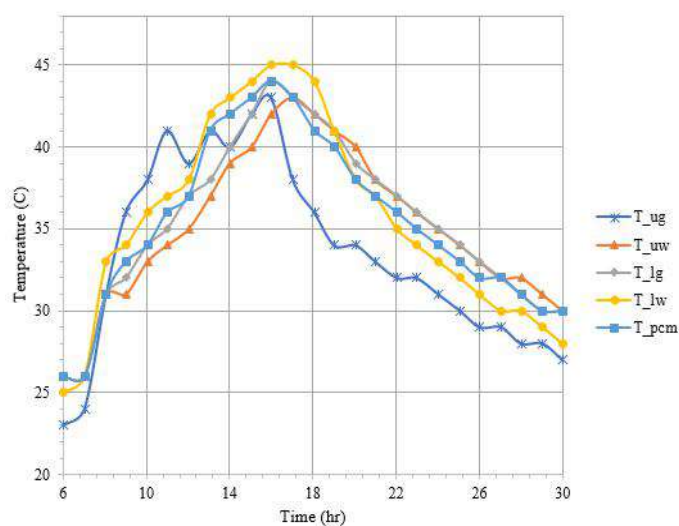


Fig.7: Twenty-four hours temperature profiles of the various still components on 2nd March, 2020

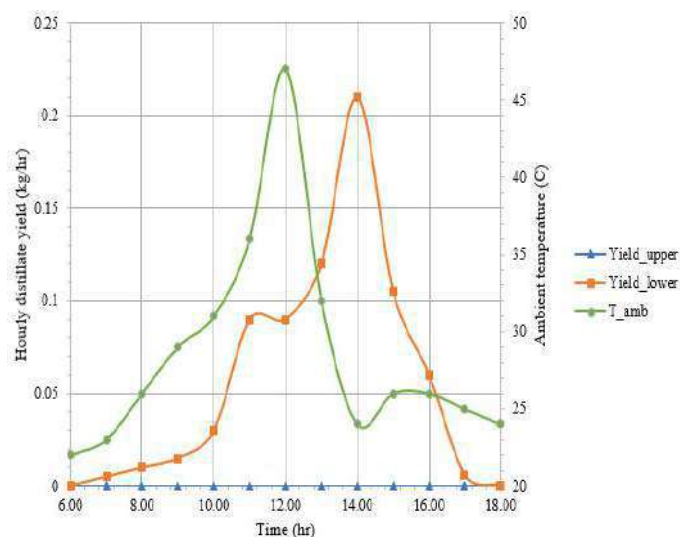


Fig.10: Diurnal variation of distillate yield vs ambient temperature on 29th September, 2020

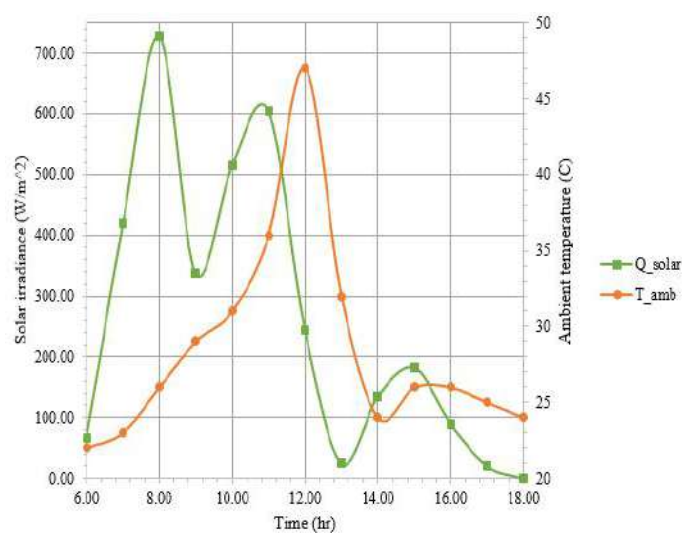


Fig.8: Solar irradiance vs ambient temperature in Owerri on 29th September, 2020

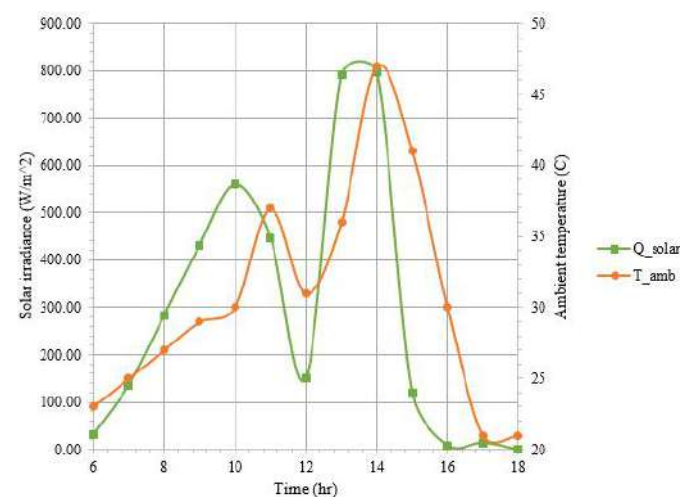


Fig.11: Variation of solar irradiance and ambient temperature In Owerri on 10th October, 2020

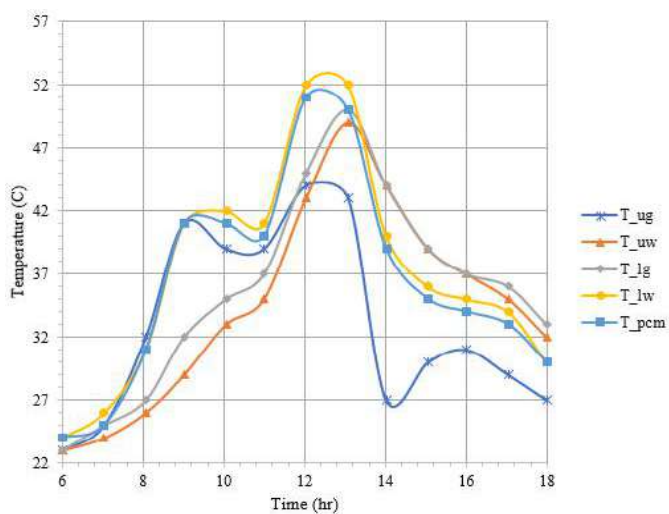


Fig.9: Diurnal temperature profiles of the solar still components on 29th September, 2020

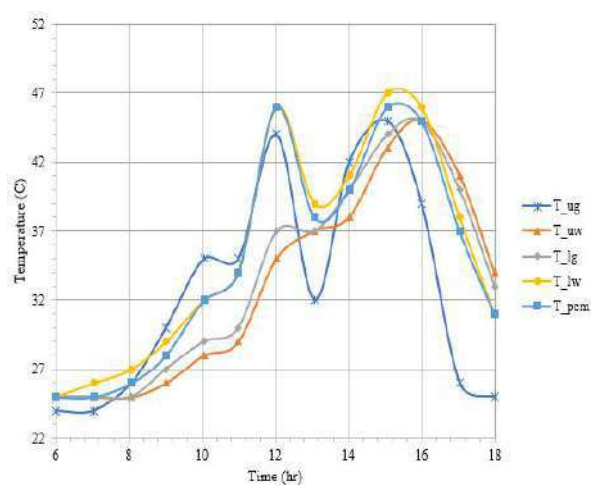


Fig.12: Diurnal temperature profiles of the solar still components on 10th October, 2020

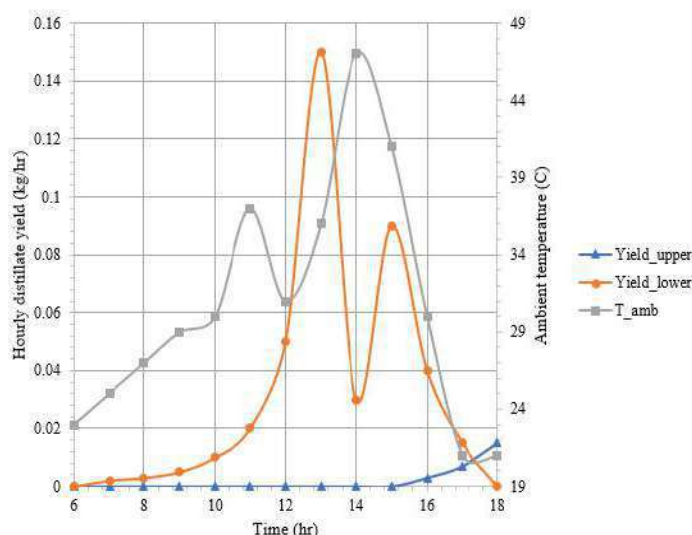


Fig.13: Diurnal variation of the distillate yield vs ambient temperature on 10th October, 2020

From figures 4 and 6, the solar irradiance peaked between the hours of 12:00pm to 13:00pm when the sun was vertically overhead [5]. From figures 8 and 11, the solar irradiance and ambient temperature showed significant fluctuations and peaked before and after noon respectively. The weather was cloudy with light shower on these test days. Figures 5 and 7 show the measured twenty-four-hours temperatures of the solar still components on 28/01/2020 and 02/03/2020 respectively. The components captured were: upper glazing, upper saline water, lower glazing, lower saline water and the PCM. The component temperatures varied in sympathy with the ambient temperature. The upper glazing was exposed to the ambient environment and as such, responded faster to changes in ambient conditions compared to the interior components. Thus, the peak of the upper glazing temperature lagged that of the ambient temperature. The PCM recorded lower temperature values compared to the interior components during the diurnal phase. During the early hours of the nocturnal phase, the PCM temperature declined the least and gradually attained the highest temperature within the solar still. At this point, the PCM functioned as the energy source thus, making the system sustainable for a given period. The interior components of the solar still achieved temperature values higher than the ambient values during the diurnal phase. This is due to the presence of the glass covers that are transparent to shortwave radiation and opaque to longwave radiation from the still interior. This phenomenon aided the internal heat retention of the system. Thus, the temperature of the exposed upper glazing reduced faster than that of the interior components and the lag between the interior component temperatures and the ambient temperature

increased. Figures 9 and 12 show the measured diurnal temperature profiles of the still components on 29/09/2020 and 10/10/2020 respectively. The temperature of the still components and the ambient followed similar profile with the lower saline water attaining the highest temperature during the diurnal phase.

The amount of freshwater yield in a solar distillation unit much depends on the difference in temperature (positive) between the humid air and condensing surface. Thus, distillate production commences only when the humid air comes in contact with a condensing surface of lower temperature compared to the dew point temperature of the humid air [22]. From Fig.10, the upper basin recorded a zero freshwater yield while from figure 13; the lower basin commenced the production of freshwater ahead of the upper basin. This is attributed to the higher temperature values recorded by the upper glazing during the day and the poor absorptivity of the saline water and lower glazing. With the reduction in the solar irradiance intensity after attaining its peak, the upper glazing temperature dropped with subsequent improvement in the upper basin performance. Thus, the lower basin achieved a better diurnal performance compared to the upper basin. The upper glazing temperature dropped significantly during nocturnal period while the reduction in interior temperatures of the still components was hampered due to greenhouse effect. Thus, the upper basin achieved an improved freshwater yield during the nocturnal phase. From Fig.10, the hourly distillate yield of the lower basin varied in sympathy with the daily ambient temperature and attained its peak value after the ambient temperature. From Fig.13, the lower basin yield attained its peak value before the ambient temperature. The ambient temperature on 10/10/2020 showed some degree of fluctuations and attained its peak two hours after noon. At this point, the temperature potential between the lower saline water and lower glazing was already on the decline and as such attained its peak value ahead of the ambient temperature. The lower basin of the system recorded maximum distillate yield rates of 0.21 L/h and 0.15 L/h at 13:00PM on 29th September and 10th October, 2020 respectively. The productivity of the system for two distinct test days is shown in Table.2

Table.2: Diurnal performances of the upper and lower basins

S/No	Dates	Upper basin diurnal yield (L/day)	Lower basin diurnal yield (L/day)
1	29/09/2020	0	0.741
2	10/10/2020	0.025	0.415

The efficiency of the system for two test days was computed with the aid of Equation (1) and is presented in Table.3.

Table.3: Diurnal efficiencies of the upper and lower basins of the double effect solar still

S/No	Days	Upper basin efficiency (%)	Lower basin efficiency (%)	Total efficiency (%)
1	29/09/2020	0	11.60	11.60
2	10/10/2020	0.66	11.16	11.81

V. CONCLUSION

The performance of a double effect solar distillation unit incorporated with a paraffin wax has been investigated under Owerri climatic conditions. The hourly distillate yields of the upper and lower basins were compared. The yield rate of both basins for the months of September and October were plotted at different time interval. It was observed that the lower basin commenced production of distillate ahead of the upper basin with the upper glazing registering higher temperature values than the lower glazing during the early hours of the diurnal phase. Thus, the lower basin performed better than the upper basin during the diurnal phase. With reduction in irradiation intensity, the upper glazing temperature dropped with subsequent improvement in the upper basin yield through the nocturnal phase.

From the diurnal temperature plots, the lower saline water achieved higher temperature values than the upper saline water due to direct contact with the absorber plate. The upper basin experienced improved temperature difference between the upper saline water and the upper glazing during nocturnal phase with subsequent improvement in freshwater yield. From the yield plots, it was observed that the lower basin's hourly yield assumed similar profile with the ambient temperature. The hourly yield attained its peak value behind the solar irradiance. This difference results from the resilience time for effective heat flow within the system. The diurnal distillate yield of the system ranged from 0.415L to 0.741L for the lower basin and zero to 0.025L for the upper basin. The system recorded an average efficiency of 11.71%.

NOMENCLATURE

η_i	Efficiency of the solar still %
\dot{m}_p	Freshwater production kg/day
A	Area of the absorber plate m ²
G	Solar irradiance flux W/m ²

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A Method to Evaluate Virtual Opponent Based on IA for an Accessible Educational Digital Game: a Case of Study with Dinobase

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Keywords— Cognitive informatics, Educational technology, Human computer interaction, Intelligent agents.

Abstract— The aim of this article is to present a method to evaluate the adequacy of a virtual opponent in a digital game. The motivation for this research arose from the lack of methodologies to evaluate a game in terms of its artificial intelligence (IA) applied to a virtual opponent when confronted with its players. The methodology for this research consisted of the case study applied with 17 children - 8 with intellectual disability and 2 with hearing impairment - in a basic school in play activities with Dinobase digital game. Dinobase is a digital game developed to help children to learn about mathematics, and it was created in a universal design approach, by considering children with disabilities. The virtual opponent must identify the level of ability from children and adapted its behavior. On previous research, the virtual opponent was evaluated with personas, on this research, we use data and analysis triangulation that involved log records, observations, interviews, and video. The results show that the methodology adopted allowed to identify the needs of improvement to the virtual opponent, that were not shown just using personas.

I. INTRODUCTION

Digital games can help students to best understand some phenomena and get them engaged in classes. According to [1], games improve cognitive development in students because they propose challenges, have rules, and demand higher order thoughts to achieve success. In Special Education, particularly, digital games can provide experiences and allow adaptations for students according to their needs [2]. Activities with digital games can be repeated and present different degrees of difficulty, which favors learning. Students learn in a playful way through digital games since they can play it.

The principle of Universal design, in this context, can be observed in order to provide a basis to the development of accessible games. According to Connell [3], universal design refers to “the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design.”

Apply this principle to educational digital games require to plan the game to be accessible by children with different disabilities, like blindness, intellectual, deafness or mobility. This is not a trivial task.

Artificial intelligence is one of the strategies to development of accessible digital games by adapting the game to the student's cognitive abilities. This was the alternative adopted by Nagasava [4] in the development of a virtual opponent to the Dinobase digital game. This strategy is promising because the game adapts to the gamer, allow him to play in a similar level of capacity against the "computer", reduce frustration and enhance engagement. The virtual opponent must learn player behaviors.

It is necessary to evaluate the effectiveness of a virtual opponent in adapting to the player's behavior, to achieve the objectives of accessibility and consequent learning. The use of “Personas” by Nagasava [4] shows some

positive results with the virtual opponent, but not uses real people. Strategies to evaluate games, like observations, interviews and logs files are proposed by [5] [6] [7], but they do not analyze artificial intelligence in games. Although some studies evaluate games, we found a lack of methods to conduct the analyses of the behavior of virtual opponents in games. This raised the need for research.

This article has the purpose to present the method adopted to analyses the adequacy of a virtual opponent in a game. We adopt a case study of the evaluation of Dinobase game virtual opponent. We present in the next sessions the Dinobase game; the method to analyze its virtual opponent; the results of its analyses and the final considerations of this study.

II. DINOBASE GAME









Dinobase is a digital game based on Base 3 analog game. Base 3 proposes to develop mathematical concepts of exponentiation, specifically the base 3. It consists of a dice and colored cards representing values of this base: 3^0 , 3^1 , 3^2 e 3^3 , respectively represented by red circles, blue squares, green triangles, and white rectangle. On each turn the player throws the dice and acquire cards with values corresponding to the number obtained. It is winner of the match the player who first acquire the white rectangle (3^3), however, as the data only has values between 1 and 6, to win the card worth 27 it is necessary exchanges cards while the player progresses in the game. The child needs to understand, for example, that to get a green triangle (3^2), he/she needs three blue squares (3^1). Thus, it is necessary to understand the relationship among quantity and image, which are not clearly exposed, requiring complex process of abstraction.

In digital game Dinobase the cards were substituted by dinosaurs' graphics elements [8]. In Fig. 1 we see the main interface of Dinobase, which has the inventory of a player, presented in his/her turn in the game. As Base 3, in Dinobase there is no relationship between the figure and the value that it represents, neither relationship between the Base 3 cards with the imageries of the Dinobase. Thus, the required level of abstraction in both games is very high, making it even more complex in the case of digital game because the player does not have at hands tangible objects to manipulate. Adaptation between these games is not something direct because of the graphical difference among them, requiring an understanding of the game to realize that they are equal. Table 1 shows the relationship between values of the items and their representations in both games.



Fig. 1: Dinobase main interface

Table 1: Values of items and their representations in Base 3 and Dinobase games

Item	Base	Dinobase
$3^0 = 1$		
$3^1 = 3$		
$3^2 = 9$		
$3^3 = 27$		

Source: [8] (adapted by author)

Dinobase 2.0 was a new version of Dinobase that allow children play against a virtual opponent. The virtual opponent was developed using the agent intelligent approach by implementing a Finite-state machine. The agent observes the player's actions and tries to play like him/her, and this way children will have an opponent with him/her similar skills. The idea is that the game will not so difficult to cause frustration neither easy, to cause lack of interest [4]. This strategy aims to offer a game that intelligently adapts to the different cognitive abilities of children, thus leading to the concept of universal design.

Dinobase 2.0 was available with personas. The technique of persona is a technique used to represent the profile of the group of users that will use the system, making possible to make implications to meet the needs of the target audience [9]. Nagasava [4] defined personas with three levels of abilities: lesser ability, intermediate ability and highly ability. In this way, the objective was to evaluate whether the virtual opponent would converge to a single skill level or would alternate between them, adapting to the skill level of the player. Tests with

personas showed weaknesses with the virtual opponent, as in the case of children who played with highly ability and had difficulty to win, which can cause frustration. This motivated the research to evaluate the game with real players with different skill levels, including children with disabilities.

III. METHOD

The method to analyses the virtual opponent of the Dinobase digital game had a qualitative approach. The research was conducted through game play workshops with children, including those with disabilities. We chose to do the tests in a controlled environment, because this approach allows the evaluator to have control over the actions of the users and to verify the environmental and social influences that can affect the performance of the actions.

We adopt different ways of acquiring and analyze data with the goal to verify if the virtual opponent had its behavior adapted to the human gamer. According to Roger, Sharp & Preece [10], to collect data on user performance, a series of methods are used to collect data, as: users' video to capture facial expressions and body language; system logs for capturing data through the system, such as mouse movement and mouse clicks; microphones in the environment for voice recording; satisfaction questionnaires or questions that ask for information about system features; and structured interviews to collect information about what they liked about the product and how it was used. So, we observe children playing the game, collect game logs, made interviews with children, analyzed pre-existing studies with Dinobase (Fig. 2). The use of diverse data in research, which is known as methodological triangulation, allow to reduce biases or deficiencies caused when we use just one method [11]. In the sequence, we explain each approach of collect data.

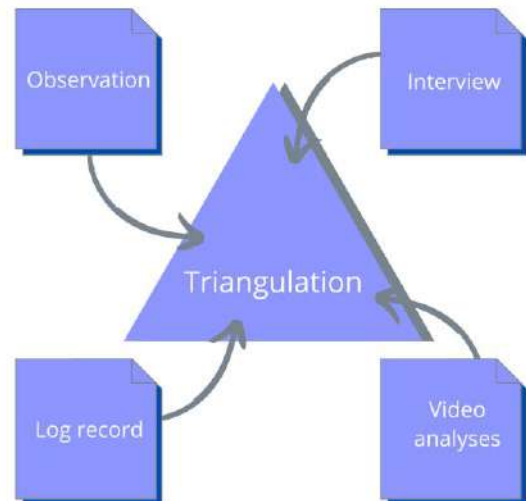


Fig. 2: The data collecting in research.

3.1 Log Record

Data logs in software have the aim to register the user's relevant events while he/she operates the software. These data can be used to audit the software, analyze its use or diagnose problems. Kakeshita and Ohta [12], for instance, use data log to analyze students' performance in answering questions, their achievement level, and their learning process. According to the authors, the instructor uses the analysis to improve the educational contents. However, in our research, the purpose with data log register is to analyze if virtual opponent behavior is accordingly with student behavior.

In the case of Dinobase 2.0 there was no data collecting, so we implemented a log register with the aim to store all the user's and virtual opponent's actions. This new version of the game is called Dinobase 2.1. Each log register is composed by the following structure: player name (VIRTUAL if it is the virtual opponent), round, date, action, action value, number of elements eggs, amount of baby elements, amount of young dinosaur elements, amount of adult dinosaur elements, total amount of score. Each log record in the log file represents one action, that can be:

1. S - play the die;
2. C - buy items;
3. T - exchange items;
4. F - end of an innings;
5. V - victory;
6. W - attempt to finish an innings without buy all possible items;
7. X - attempt to acquire items without having points;
8. Y - attempt to make exchanges without selecting elements or not having necessary punctuation.

In our experiment with children, Dinobase 2.1 registered all actions performed by students and virtual opponent, which were analyzed and are presented at section Results.

3.2 Observation

Observation is a technic of data collection that allows researchers to see, to hear and to exam facts or phenomena that they want to study [13]. This technique requires direct contact with reality and allow researchers to identify and get proves about the person behaviors while in contact with the object of study. Observation as a scientific technique needs a plan, methodical registration, and verifications and controls for its validation. In our research, observation was conducted through a systematic approach, by observing students in workshops of game play.

Observation was conducted by two researchers, who take notes on a form previously prepared. This team observation, according to Marconi & Lakatos [13] is advisable since they can observe the phenomena through diverse angles. So, each question from the form was discussed by the researchers, that way there were a consensus about children behavior. The questions are:

1. Did the child present any difficulties in understanding the functioning of the game?
2. Is the child unsatisfied because the game is too difficult?
3. Is the child unsatisfied because the game is too easy?
4. Does the child show disinterest in playing the game?
5. Has the child lost focus during game play?
6. Has the child failed to purchase items drawn before the end of the innings?
7. Has the child failed to exchange available inventory items when possible?

3.3 Interview

The third approach to data collect was based on interviews with students after play Dinobase game. The interview is a meeting between two people to obtain information about some subject in an oral form [13]. On our research, interviews had the intention to get from the children their feelings, satisfaction, and fun playing Dinobase.

The interviews were standardized and structured [13], so the answers could be compared. For each question, we write down two (2) for the answer "always", one (1) for "sometimes", and zero (0) if the children answered "never". The questions were:

1. Did you like the game?

2. Would you like to play again in another opportunity?
3. Were you able to defeat your opponent?
4. Did you play against another child who was on another computer or played against the computer?

This last question, in particular, aims to investigate how children perceive the virtual opponent. A virtual opponent must be as real as possible, that is, it is not enough to fulfill its basic function in the game, which is to interact with other players within the logic proposed for the game, it must also present natural behaviors of a human player, such as know the environment in which it is inserted, display emotions and personality as if it had a life of its own, with the goal of human players questioning themselves against who they are playing [14].

3.4 Video recording and analyses

Dinobase and Base 3 were used in former research, as tools to help children to understand digital games engines. On this research, children were filmed and analyzed thought narrative analyses [15]. We use those materials to analyze children behavior in playing the game, with the objective of validating the profiles classified by Nagasava [4] and to prepare to the workshops. The identification of a new profile would be of great impact, having an enormous gain for the improvement of the virtual opponent and to make it more complete.

The videos and narratives were analyzed to observe if during the rounds: (i) the player stopped making purchases even with available points and (ii) the player stopped making exchanges even with elements to do so. These behaviors show the student understanding about the game. The players behavior did not change during the match, due to the matches being short. No player presented significant evolution during one single match, that means, no one initiate a match presenting great difficulty and finished it with great dominion in understanding the thematic of the game. However, it was verified that the players acquire knowledge when playing several matches, that can influence the results of this research.

The analysis of videos and Alves' narrative [15] confirmed the profiles classified by Nagasava [4] that it, three levels of players' ability. This helped for the preparation for the workshops with children since we had data to assist in conducting the evaluations.

3.5 Research place and participants

The research was conducted in a public school in the city of Itajaí – SC, Brazil. The school selected was the Basic School José Fernandes Potter, located in the Espinheiros neighborhood. The choice of this educational establishment was due to its characteristics of specialized educational services, and for attending countless children

with disabilities in the age group defined for the research, that means, 8 to 10 years old. the research was authorized by the Education Secretary of Itajaí, Santa Catarina, Brazil and all ethical aspects were respected.

The teacher of the SRM (Multifunctional Resource Room) - where the specialized education is conducted in opposite shift from regular classes - helped to define the group of children for the research. Her participation was important because Dinobase was created in the context of special education, notably for children with intellectual disabilities. To conduct the research, we needed children with diverse levels of intellectual ability, so we define to include children with and without disabilities. A total of 17 children were selected, among them 8 with intellectual disability and 2 with hearing impairment. All of them within the age range defined for the research. Parents were informed about the study and agreed to the participation of their children through consent form.

The workshops were held in a single day. Children divided into groups and invited to play Dinobase 2.1, each one on a computer, individually. The children received general instructions about the operation of the game before play. All actions that they performed within the game were saved in log files for further analysis, they were photographed and filmed, and we took notes on the observation form. The individual interview was made immediately after the child play the game. Fig. 3 shows some children playing Dinobase 2.1.



Fig. 3: Children playing Dinobase 2.1

IV. RESULTS

With the objective of evaluate the virtual opponent of Dinobase 2.1, we performed the workshops with children, with and without disabilities. Too many data were collected on this activity, since we decided to construct a data triangulation so that we could conduct the results to have a realistic analysis about the artificial intelligence applied to the game. Thereby, the data analysis was divided into: (i) analysis of the data generated from the observation of children in game play activity and interviews with children after game play activity; (ii)

analysis of the videos recording with the children in game play activity; and (iii) analysis of the log registered during children's activities.

4.1 Analysis of children in play activity: observations and interviews

Children behavior in game activity were analyzed through the notes made during the observation and the interviews with children after the game activity, with the intent to verify if there was any dissatisfaction generated by the virtual opponent that could make the child lose interest in the game and if they realized who was their opponent.

The analyze shows that five children (29.41%) at some point in the matches were dissatisfied because the virtual opponent made it easier to play; three children (17.65%) demonstrated at some point their dissatisfaction with the game because it was very difficult, among them two are children with more accentuated intellectual impairment; the other children (52,94%) showed satisfied with the game.

Looking to the difficulty to play Dinobase 2.1, five of the 17 children (29.42%) had difficulty in understanding the gameplay, eight (47.06%) presented some difficulty at some point; and four of them (23.52%), did not present any difficulties in any moment.

About the interest in the game, just four children presented at some point disinterest during the matches, and these were the same children who presented more difficulty in understanding the game. Other seven children lost focus on the match in some moments, but the videos of the workshops help to observe that those distraction due because some external factors draw attention, not due to the dissatisfaction for the game.

All children failed to make purchases and exchanges at some time, this shows that no child had full control over the operation of the game.

The interviews with children show that they liked the game and would play it again, this shows that the game was interesting and fun for them. All children answered that they managed to beat the virtual opponent, but observation shows that some children had not been able to beat it. When asked who the opponent was, all children responded that they were playing against the "computer" and not against another child. When asked why, some children responded that they did not know the answer, other, however, responded that the actions the computer took were very fast, so it did not appear to be actions done by a child.

The experiment shows that sometimes the virtual opponent facilitated the play, and sometimes it turns it

more difficult, also, children realized that they are playing against a software, and not another human being. Those results reveal that the virtual opponent behavior is not adequately balanced according to children's abilities. According to Monteiro & Santos [14], games become more interesting when the player believes he is interacting with another human, so his actions are not so predictable, which makes the game more challenging and fun. To Ravysse, Blignaut, Leendertz et al [16] some success factors for a serious game include realism, interaction, and adaptivity. If the game cause frustration, the player may decide not to play it anymore, and in the case of an educational game, the learning intention will not be fulfilled.

4.2 Video recording analysis

Children behavior and engagement while playing Dinobase were analyzed through the videos recorded during the workshops. We adapted the Involvement Scale proposed by Cathcart [17], so we analyzed children's level of concentration, energy, complexity, facial expression, persistence, time to play, and their comments. The Involvement scale allow understanding if the child is engaged in the activity, which is a necessary condition for her/his learning. For each child, the Likert scale values from 1 to 5 (where 1 is very low and 5 is very high) were defined for each item. The results are:

- **Concentration:** defines the concentration level of children during the game play. From 17 children, 11 had very high concentration, 6 children had medium and high concentration. Those data demonstrate that children were engaged to play and trying to win the game;
- **Energy:** defines child's willingness to participate in the workshops. Children who were quiet, shy and/or unwilling to attend workshops were considered with low energy. Many children started the workshop very shy because they were dealing with the researcher who is a stranger to them. Slowly, they were more relaxed and ask questions about the game, even so, children's energy level was assessed from low to medium. Of the total children, 4 received a low score, 7 received an average score and 6 children received a high score;
- **Complexity:** child's ease in carrying out activities that require high mental effort. Low scores were given to children who demonstrated greater difficulty in performing tasks that required high attention. Of the total, 9 children received medium, low and very low scores, 3 of them have intellectual disabilities. Eight children received high and very high scores for this characteristic, 5 of them have intellectual disability and 2 of them have hearing impairment;

- **Facial expression and posture:** define whether the child demonstrates satisfaction, doubt or astonishment in carrying out the tasks and whether the child maintains the posture during the difficulties presented in the game. Children received high and very high scores, with only 3 children receiving low scores for this characteristic, coincidentally they were children with intellectual disabilities who at some point did not accept that the virtual opponent was winning the match with some ease. The data show that the children maintained their posture even in times of difficulty and facial expression showed satisfaction in most of the time;
- **Persistence:** defines whether the child maintains persistence in reaching the proposed objectives even in the most difficult moments. All children participating in the workshop received a high and very high score for this characteristic (14 children received a maximum score). This shows that children were very excited to participate in the workshop and overcome the difficulties that the game presented;
- **Accuracy:** defines child's accuracy in the game activities, received a low score if he / she took the games in trial and error. Accuracy was the feature that received the lowest score among all the other features. Only 3 children received a high score, 8 children received a low and very low score;
- **Reaction time:** defines the reaction time of children, if it takes a long time to perform a certain action. Even children with intellectual and hearing disabilities had good scores for this characteristic, in total, 8 children received high or very high scores (6 of them with intellectual or hearing disabilities). Only 4 children received a low or very low score;
- **Verbal comments:** verification of the child's participation and interest in the workshop, whether with comments, interest in questioning colleagues, concern about making good starts. Only 5 children received a high or very high score for this characteristic. This defines that children were very quiet during the workshop, few of them asked questions about the actions or functioning of the game. Many children felt ashamed to ask or answer the questions the researcher asked.

4.3 Log analysis

In taxonomy - player modeling proposed by [18], Off-Line Review is the evaluation of a game log after its completion. The Off-Line Review proposes to analyze the different states of the player or agents applied to the game

to reach a set of information for the purpose of create strategies or improve the characters involved.

The analysis of the logs allowed verify whether the virtual opponent was balanced in a way to behave similarly to the player, adapting to his skill level. The logs also sought to assess whether the virtual opponent facilitated or hindered the game for the player, an important factor for the child to have the opportunity to learn from the game.

Logs of 3,147 actions were collected over 31 matches. Some children played more than one match because they had more time available for the workshop. All the clicks the player made during the game were considered actions, that is, clicks on buttons, inventory items, purchasing actions, item exchanges and end of the round. Clicks on non-clickable areas of the game were not considered.

Virtual opponent won 9 matches out of the 31 disputed, that is, the percentage of victory was 29.03%. It was expected about 50% of victories if the virtual opponent had similar actions to the player, so this percentage was considered low. In a detailed analysis of the logs of these 9 victories, in 2 of them the player did not win because he/she did not make the correct move, it means, he/she did not realize he/she has the points to win. The other 7 matches the virtual opponent was very advantageous in the raffle of values and it would be very difficult for the player to be the winner. In other words: in 7 of the 31 matches (22.59%) the virtual opponent won easily due to having more luck in the raffle of values. On the other hand, from the 22 matches in which the player was the winner, 4 of them the virtual opponent already had the necessary score to win but it let the player win because he/she had great difficulty on playing. 8 of them the virtual opponent did not even did 21 raffle points, so the player had a lot of advantage in the raffle of values and the virtual opponent had no chance to a competitive game. These results shows that the luck factor of the game does not make it competitive. In addition, the match always starts with the player, causing a disadvantage to virtual opponent.

The exchange of items to progress in the game are fundamental actions in Dinobase because it is through them that the child develops their understanding of mathematical concepts involved and can achieve victory in the game. For the 31 matches, in 20 of them (64.52%) the percentage of rounds that the virtual opponent failed to make exchanges was higher than the percentage of rounds that the player failed to make exchanges; in 8 of them (25.80%) the percentage of rounds that the player failed to make exchanges was higher than the percentage of rounds that the virtual opponent stopped making exchanges and in 3 matches the player and the virtual opponent made the

exchanges whenever possible, not accumulating elements in the inventory. The data show that the virtual opponent did not act in a similar way to the player's actions. Often, the virtual opponent "facilitated" the game by not making the possible exchanges, even though the player was playing optimally.

To verify the children's learning, the total of their actions were analyzed. The objective was to check if the players were understanding the game or just playing with trial-and-error actions. For this case, we considered the matches that presented more than 30% of the wrong actions as a learning margin. Only 6 of the 31 games were above the 30% learning margin. In other words, it can be considered that 19.35% of the matches were played through trial-and-error due to the children not understanding the real value of the elements to correctly carry out the purchase and exchange actions.

The analysis of the actions in play of some children, revealed relevant information for the assessment of the virtual opponent. One of them, a hearing-impaired boy, was very interested in the game and played 7 matches of Dinobase. He won 6 matches (85.72%), in which the virtual opponent did not reach the necessary score for the victory, that is, he won easily due to being luckier on raffle. After a few matches, the boy realized that the virtual opponent was performing purchase actions like his. So, he started to buy only elements of lesser value, with the objective of deceiving the virtual opponent, making him only buy the items of lesser value. Through the logs it was possible to notice that the virtual opponent considered the purchase of items more preponderantly, not reproducing the exchange actions in the same way as the player. The child's perception of this behavior allowed him to "cheat" the software.

Another player showed different behaviors. The boy with severe intellectual disability had difficulty in socializing, communicating, and understanding how the game works. From the logs of his matches, it is observed that the boy did not make the necessary exchanges to progress in the game and in most cases he's actions were by trial and error. Checking the videos of the workshop, the player frequently asked his colleagues or the teacher why he was unable to perform a certain action. The boy played 3 matches and won 1 of them. The luck factor was again observed in the raffle of points. The virtual opponent, in this case, behaved appropriately, making few item exchanges, just like the player.

4.4 Recommendations towards virtual opponent's Improvement

The triangulation of data made it possible to examine the game Dinobase and its virtual opponent through

several dimensions. The analysis of children's behavior and their perceptions increased understanding of their relationship with the game, the fun promoted, and of the learning possibilities. The records of actions (logs) presented quantitative data that revealed weaknesses and potentialities of the virtual opponent and corroborated the actions of the children, observed empirically. This analysis made it possible to develop recommendations for improvements for future implementations of the game under study.

- Slower presentation of the virtual opponent's actions on the interface: all the children realized that they were playing a game against the "computer". According to [14], if the child does not realize that he/she is playing against a virtual opponent, he/she may take the game more seriously, having a greater rivalry for thinking that he/she is playing against another child, then it is recommended to leave the agent's actions slower. With this measure, the player will be able to better visualize opponent's actions, so he/she could reflect on the play and promote learning;
- Visual move: the game visually presents just the result of the virtual opponent's move, not allowing the player to view the choices of items made for the exchange, that is, their movements in the inventory. It is suggested that this move is like that of the player, that is, that is, that visually the selected items are "clicked" by the virtual opponent. Learning also takes place with the observation of the opponent's play, so this aspect is fundamental;
- Agent perception: Children found irregularities in the agent behavior and so they were able to define strategies to defeat him. The virtual opponent did not realize that it is playing with the same child and resumes his/she is learning with each match, while the child improves his/her skills. Thus, it is recommended that the agent keep the player's information and, when starting again, already have knowledge of his skill;
- Start of the match: the first round in the game always starts with the player, giving him an advantage over the virtual opponent because he has more chances to add up the points needed to win. To minimize this problem the game must make a raffle to decide who starts the match;
- Virtual opponent actions: data analysis showed that virtual opponent does not exhibit a behavior similar to the player, especially when exchanging items. It is recommended to revise the algorithm to improve the perception of the way the player performs his moves and adapt the virtual opponent's moves to approach the player's skill level.

V. CONCLUSION

The objective of this paper is to investigate methods to analysis of the virtual opponent's behavior in digital games, with the purpose of validating their suitability to the skill levels of players. For this purpose, the authors carried out a case study of the digital game Dinobase, a potentiation learning game proposes to develop mathematical concepts of exponentiation, specifically the base 3.

The analysis involved the triangulation of data that was collected in different forms: users' video in game activities; system logs; voice recording; and structured interviews. These data were analyzed in a qualitative and quantitative approach, and demonstrated several weaknesses of the virtual opponent, for which suggestions for improvements were presented.

The study revealed the need to evaluate the game under different aspects, emphasizing the participation of students with and without disabilities, and their different levels of skills and knowledge. The child's perception of the game is a major factor, however the analysis of the logs made it possible to observe in depth the actions, which in some cases contradicted the students' actions.

The recommendations presented in this article were implemented in a new version of the game Dinobase [19] and can be downloaded at <https://univalildi.wixsite.com/univalildi/dinobase>. It is suggested as a future work the revaluation of the game through the methodology proposed in this article, with the view to validate both the methodology and the effectiveness of the recommendations implemented in the new version of the game.

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Analysis of Putting up Piles using Empirical Methods

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Keywords— Foundation; Repression;
Piles.

Abstract— Civil construction in Brazil has made great progress in recent decades, and it has become necessary to use in-depth studies of the resistance capacity of certain types of soils. The calculation methods unfortunately did not advance, the last ones were developed in the 1980s. The pile-type foundation in compliance with the settlement, presents a quick, economical solution and serves the distribution of loads in resistant soil very well, in addition to to be carried out with great depths. The present article has as general objective general objective to carry out the analysis of settlements in piles using empirical methods. In order to achieve the general objective, the following specific objectives are achieved: To carry out a theoretical survey; describe the types of settlement in piles using empirical methods; and to analyze the settlement in piles using empirical methods. A bibliographic review was carried out on the analysis of settlement in piles using empirical methods, emphasizing the empirical methods: Aoki-Velloso, the Décourt-Quaresma method and the Velloso method).

I. INTRODUCTION

In all construction works one must carefully pay close care for a stage of construction that is responsible for transmitting all the loads that will act in this building for layers of resistant soils, this stage being called foundation.

The foundation project is of fundamental importance in engineering, since it can compromise the entire structure supported to it. Given this, there is a whole process for choosing the type of foundation suitable for the desired project. This process takes into account aspects of the shape of the element for sizing, the weight of the structure that will be built on the foundation and the soil profile where the building will be executed.

For [1] the "isolated element of foundation" is nothing more than the component of the structure that transfers load to the soft part of the soil, in which it is usually the weak part. Thus, the soil a natural material, its behavior and resistance provide great variability, which makes the design of foundations unique for each work.

These days, the foundation technique has evolved a lot, but the purpose is the same. According to [2], the foundation is part of the process that transmits the

construction load to the ground by the base, tip resistance and its lateral surface or, still a combination of the two.

For the correct elaboration of a foundation project, it is necessary to carry out the forecast of load capacity assigned to the piles. The study of the load capacity of the cuttings can be developed from theoretical methods or by empirical methods.

Empirical methods is nothing more than the application of a safety factor in soil rupture stress, in order to reduce its resistance, the safety factor varies according to soil situations, however this factor varies between 2 to 3[3].

The recalque, in turn, differs according to the sturdy plane composed by the tip of the piles within the geotechnical massif, which was defined in design. In the case of continuous helix piles, the recals depend on the deformation of the massif that surrounds the piles, the deformation of the materials that make up the structural element of the piles, and their dimensions.

According to [4], it is possible to indicate three types of refills due to static loads: by elastic deformation, lateral flow and densification.

The present work has as general objective to perform the

analysis of recalques in cuttings using empirical methods. To achieve the general objective, the following specific objectives are: To carry out a theoretical survey; describe the types of recalques in cuttings using empirical methods; and to analyze the recalques in cuttings using empirical methods.

II. THEORETICAL FOUNDATION

2.1 SOIL CLASSIFICATION AND ANALYSIS

For [4], there are two main soil classification systems:

The Unified Classification System (U.S.C.), derived from the Airfield Classification System (A.C.), designed by A. Casagrande; The H.R.B. (Highway Research Board) classification, originated from the Public Roads Administration classification."

The author also divides the Unified Classification System into three major groups:

Coarse soils: these are those whose diameter of the absolute majority of grains is greater than 0,074 mm (more than 50% by weight of their grains, are retained in sieve n°.200). Fine soils: those whose diameter of the absolute majority of grains is less than 0,074 mm. Peats: highly organic soils, generalismente fibrillar and extremely compressible.

With regard to soil analysis [5], it establishes that it is necessary to obtain adequate knowledge of soils. It is necessary to identify and classify all the layers that make up the substrate to be analyzed, as well as its properties.

The determinations of substrate properties are analyzed through field tests, where those that stand out are [6]:

- The Standard Penetration Test - SPT;
- The Standard Penetration Test complemented with torque measurements - SPT-T;
- The cone penetration test - CPT;
- The cone penetration assay with measurement of neutral pressures, or piezocone - CPT-U;
- The vane test;
- Geophysical tests, in particular the Cross-Hole test..

2.1.1 STANDARD PENETRATION TEST – SPT

Percussion test probes are perforations capable of determining the depth of the water level and obtaining characteristics of different soil types. The hole is coated if unstable, otherwise it is uncoated, adding bentonite mud to the water. Drilling advances as the soil is removed with the help of a trépano and by water circulation.

Claims that percussion probing is a procedure that aswells soil resistance along the perforated depth, as it is

able to show the subsoil [6]. The SPT assay is standardized by [7], whose purposes are defined by it: "the determination of the type of soil according to the depths of occurrence; the position of the water level and the penetration resistance indexes (N) at each meter.

Standard Penetration Test (SPT) represented in Figure 4, the most widely used, the "sampler barrel" (fig.5), with 2" and 1 3/8" of external and internal diameters, respectively, and which opens longitudinally (for sample removal), is fixed at the end of the 45cm crimping rods on the ground, inside the probing tube. The crimping is made by a weight of 65kg, with 75cm of fall height. First, 15cm is penetrated and then the N number of blows applied to the other 30cm is recorded, annotating separately every 15cm [4].

According to [7], the determination of the penetration resistance index occurs by the number of strokes corresponding to 30cm of the sampler – standard, after the initial crimping of 15cm, using sisal rope to lift the standardized hammer.

2.2 DEEP FOUNDATIONS

According to [8], deep foundation is an element that transmits the load to the ground through its base, or by its lateral surface, or by combining the two. It must be seated at least 3 metres deep. For [8], deep foundations are of two types: piles and tubulões.

Piles: elements executed entirely by equipment or tool, without, at any stage of their execution, there is a person's descent. The materials used can be wood, steel, precast concrete, concrete molded on site or by its combination [8].

According to [8], the continuous helix type monitored piles are defined as:

Piles of reinforced concrete molded in loco, executed by means of the introduction, by rotation, of a continuous helical traffic in the ground, and injection of concrete by the central rod of the trough itself simultaneously with its removal, and the reinforcement is introduced after the concrete of the pile [8].

For [9], the use piles can be qualified as displacement and excavated piles. Where in the excavated piles are the continuous helix cuttings, type "Strauss" among others. Excavated piles are those executed "in situ" through the drilling of the ground by any process, with removal of material, with or without coating, with or without the use of stabilizing fluid [9].

According to [10], recalque is the modification of the soil when subjected to loads, causing movement in the foundation that, depending on the intensity, can result in serious damage to the structure.

When a foundation element moves vertically, an absolute

reload is configured. The difference between the absolute recalques of two elements of the foundation is called differential recalque. The differential repress imposes distortions on the structure that can lead to cracks [11].

The [8] establishes that in works where the most important loads are vertical, the measurement of the recalques is the fundamental resource for observing the behavior of the work. The standard adds that this measure aims to allow the comparison of measured values with calculated values, aiming at improving the methods of forecasting of recalques.

Nevertheless, [12] state that the Brazilian practice of foundations consists of performing control of recalques only in situations where problems are observed in buildings, such as cracks or cracks. They emphasize the importance of the measurement of the recalques since the beginning of construction as a quality control of the foundations.

In 1975, the first method of Brazil for the evaluation of cutting load capacity was born, elaborated [13]. From there, other methods were elaborated by different authors. According the methods of [13] and [14] are the most used by Brazilians to reach the load capacity of piles. They are considered semi-empirical, based on both theoretical aspects and correlations obtained from CPT and SPT assays, respectively.

2.2.1 AOKI AND VELLOSO METHOD (1975)

In the method proposed by [13], the tip limit stress and lateral friction of the cutting can be found from the values obtained through the results of static cone penetration tests, CPT, using Equations 2.6 and 2.7 and the coefficients F_1 and F_2 .

According to [15], the load capacity is scaled by the deduction of the unknowns of high-end resistance (R_p), and lateral resistance (R_l), as expressed in equation 01:

$$R_p = r_p \cdot A_p + U \cdot \sum_{i=1}^n (r_{li} \cdot \Delta l_i) \quad (\text{Eq:01})$$

where: r_p = Load capacity in the stake nesting quota (Mpa);

A_p = Tip cross section area (m²);

r_l = Lateral friction in each layer of soil (Mpa);

U = Perimeter of the cross section of the stet (m);

Δl = Layer height (m).

Says that the load capacity values in the settlement quota (r_p), and lateral friction in each layer of soil (r_l), is defined through equations 02 and 03 [15]. Equation 04 defines the total load capacity.

$$\text{SPT: } r_p = (k \cdot N_p) / F_1 \quad (\text{Eq:02})$$

$$\text{SPT: } r_l = (\alpha \cdot [k \cdot N]_{-l}) / F_2 \quad (\text{Eq: 03})$$

$$R = (k \cdot N_p) / F_1 \cdot A_p + U / F_2 \cdot \sum_{i=1}^n (\alpha \cdot K \cdot N_{li} \cdot \Delta l_i) \quad (\text{Eq: 04})$$

The parameters of F_1 and F_2 are arranged in the figure 1.

Tipos de estacas	F_1	F_2
Franki	2,5	5
Pré-moldadas	1,75	3,5
Escavada	3	6

Fig.1: Transformation coefficient F_1 and F_2 .

Source: [13] and [1]

The K and α coefficients are shown in the figure 2.

Tipos de solo	K(Mpa)	α (%)
Areia	1,00	1,40
Areia Siltosa	0,80	2,00
Areia Silto-argilosa	0,70	2,40
Areia argilosa	0,60	3,00
Areia Argilo-siltosa	0,50	2,80
Silte	0,40	3,00
Silte arenoso	0,55	2,20
Silte areano-argiloso	0,45	2,80
Silte argiloso	0,23	3,40
Silte argilo-arenoso	0,25	3,00
Argila	0,20	6,00
Argila arenosa	0,35	2,40
Argila areno-siltosa	0,30	2,80
Argila Siltosa	0,22	4,00
Argila silto-arenosa	0,33	3,00

Fig.2: Coefficient K and α .

Source: [15] and [1]

2.2.2 METHOD OF DÉCOURT AND LENT(1978).

According to [15], the load capacity (R), is determined by calculating the lateral resistance parameters (R_l) and cutting-edge (R_p) respectively expressed by the equation 05:

$$R_l = r_l \cdot S_l \quad e \quad R_p = r_p \cdot A_p \quad (\text{Eq:05})$$

In which: r_l = Lateral friction in each layer of soil (Mpa); S_l = Cutting length (m); r_p = Load capacity in the stake nesting quota (Mpa); A_p = Tip cross section area (m²).

Towards [15], Lateral friction resistance (r_l), is calculated by means of the average value of the SPT penetration resistance index along the SPT (N_l), being expressed by the equation 06:

$$r_l = 10 \cdot \frac{N_l}{3+1} \quad (\text{Eq:06})$$

According to [15], the calculation of the load capacity of the pile base (r_p), is estimated by the equation 07:

$$r_p = C \cdot N_p \quad (\text{Eq:07})$$

Where: N_p = Average SPT value at the base of the pile, above and below the foundation tip (Kpa);

C = Characteristic soil coefficient, sized according to figure

3 (Kpa).

Tipos de solo	C (kPa)
Argila	120
Silte Argiloso*	200
Silte arenoso*	250
Areia	400

* Alteração de rochas (solos Residuais)

Fig.3: Characteristic soil coefficient (C).

Source: [14]

Introduces factors (α) and (β), respectively in the tip and side resistance plots, resulting in the load capacity according to the equation 08 [16].

$$R = \alpha \cdot C \cdot N_p \cdot A_p + \beta \cdot 10 \cdot \frac{N_l}{3+1} \cdot U \cdot L \quad (\text{Eq:08})$$

In which: α e β = Factors depending on the type of pile and soil represented in tables 4 and 5 respectively.

Tipo de solo	Tipo de estacas				
	Escavadas em geral	Escavadas (bentonita)	Hélice contínua	Raiz	Injetada sob alta pressão
Argila	0,85	0,85	0,30*	0,85*	1,0*
Solo intermediários	0,60	0,60	0,30*	0,60*	1,0*
Areias	0,50	0,50	0,30*	0,50*	1,0*

* valores apenas orientativos diante do reduzido número de dados disponíveis

Fig.4: Factor values α depending on the type of pile and soil.

Source:[16]

Tipo de solo	Tipo de estacas				
	Escavadas em geral	Escavadas (bentonita)	Hélice contínua	Raiz	Injetada sob alta pressão
Argila	0,80*	0,90*	1,0*	1,5*	3,0*
Solo intermediários	0,65*	0,75*	1,0*	1,5*	3,0*
Areias	0,50*	0,60*	1,0*	1,5*	3,0*

* valores apenas orientativos diante do reduzido número de dados disponíveis

Fig.5: Factor values β depending on the type of pile and soil.

Source: [16]

2.2.3 VELLOSO (1981)

Says that the cutting edge resistance (R_p) and lateral resistance (R_l) are determined using equations 09 and 10 respectively. Finding the total load capacity through equation 11, the values of α , β and λ [15].

$$R_p = \alpha * \beta * q_c * A_p \quad (\text{Eq:09})$$

$$R_p = \alpha * \lambda * U * \Sigma(f_c * \Delta_l) \quad (\text{Eq:10})$$

$$R = R_l + R_p \quad (\text{Eq:11})$$

In which: α = Station execution factor (table 9); λ = Loading factor (table 9); β = Base dimension factor (table 9); U = Perimeter of the cross section of the steel (m);

A_p = Base cross-section area (m²);

Δ_l = Height of soil layer (m);

R = Total resistance (Mpa);

R_l = Lateral resistance (Mpa);

R_p = Cutting-edge resistance (Mpa).

	α	λ	β
Estacas escavadas	0,5	-	-
Estacas cravadas	1,0	-	-
Estacas comprimidas	-	1,0	$1,016 - 0,016 * \frac{D_b}{d_c} \geq 0,2$
Estacas tracionadas	-	0,7	$D_d = D_f$
d_c = Diâmetro da ponta do cone no CPT; D_b = Diâmetro da base; D_f = Diâmetro do fuste.			

Fig.6: Values of α , β and λ .

Source:[1]

According to [1] in the case of using ptS in this method, the correlations expressed in equations 12 and 13 are adopted, respectively.

$$q_c = \alpha * N^b \quad (\text{Eq:12})$$

$$f_c = \alpha * N^b \quad (\text{Eq:13})$$

In which: a, b, a' and b' are correlation parameters to be defined for the typical soils of the construction site, according to figure 7.

Solo	Ponta		Atrito	
	a (kPa)	b	a' (kPa)	b'
Areias sedimentares submersas (1)	600	1	5,0	1
Argilas sedimentares submersas (1)	250	1	6,3	1
Solos residuais de gnaiss areno – siltosos submersos (1)	500	1	8,5	1
Solos residuais de gnaiss silto – arenosos submersos	400 (1)	1 (1)	8,0 (1)	1 (1)
	470 (2)	0,96 (2)	12,1 (2)	0,74 (2)
(1) Dados obtidos na área da Refinaria de Duque de Caxias (RJ).				
(2) Dados obtidos na área da Açominas (MG).				

Fig.7: Approximate values of a, b a' and b'

Source: [1]

2.3 STATIC LOAD TEST TEST

Tends to provide information to describe its load x displacement conduct and evaluate its load capacity qualities. It applies to all stake typologies, regardless of the execution process [17].

According to [17], the execution process is initiated when you have a load application device composed of one or more hydraulic jacks powered by electric or manual

pumps acting against a stable reaction system.

Stresses that in the execution of the load test, the pile is loaded until rupture or at least up to twice the estimated value for its workload. Initially, a load of no more than 20% of the maximum expected load value is applied through a hydraulic pack and pump. A new load starts after the reset has been stabilized [17].

Ensures that even when the safety factor is not expected

to decrease, it is valuable that every work with more than 100 piles has at least a static load rating [18].

According to [17], the Static Load Proof test can be running debt with slow or fast loading. What differs are the load applied at each stage, and in slow loading it should not exceed 20% of the expected workload. In fast loading this percentage drops to 10%. The time maintained until displacement stabilization is 30 minutes at slow and 5 minutes in fast.

III. MATERIALS AND METHODS

The methods are nothing more than satisfactorily general techniques to turn common procedures to an area of science or to all sciences. In this stage will be addressed the methods that will serve to propose an excellent work, which will contribute to the performance of the research.

3.1 DESCRIPTIONS AND LOCATION

This study was carried out in the municipality of Gurupi state of Tocantins. It is located in the south of the state, on the banks of the BR-153 (Belém-Brasília Highway), 223 km from Palmas, the state capital, and 742 km from Brasília. It lies at the watershed between the Araguaia and Tocantins rivers, at a latitude 11°43'48" south and at a longitude 49°04'08" west, being at an altitude of 287 meters. Its estimated population in 2018 was 85,737.

The methodological procedures seek to guide the research work, defining the means used to achieve the main objectives of the research.

It should be emphasized that in all research it is fundamental to use scientific methodology, since these passes greater credibility of the work as stated by

"The scientific method wants to discover the reality of the facts and these when discovered must, in turn, guide the use of the method. Therefore, method is only a means of access; only intelligence and reflection discover what facts and phenomena really are [19]." The methodology teaches how to seek real truth in the face of facts that are still purely theoretical.

The research is classified as exploratory, because according to [20] "exploratory studies do not elaborate hypotheses to be tested at work, restricting themselves to defining objectives and seeking more information on a given subject of study".

Also, he says that this method "has the effect of a more precise research, or, still for the elaboration of hypotheses" Having other aspects, such as enabling the researcher to make a provisional survey of the phenomenon he wishes to study".

The proposal used the descriptive method that according,

"descriptive work seeks to cover general and broad aspects of a context, also give room for the explanation of the cause and effect relationships of phenomena"

In the research process, the bibliographic technique was used, because according to [21], "bibliographic research is the systematized study developed as a basis for material published in books, magazines, newspapers, electronic networks, that is, material accessible to the general public".

The bibliographic research allows the researcher to reach a wide and extensive range of information regarding the phenomenon studied, it is a research with global scope, since, with the advent of technological transformation, increasingly accessible, it is possible to obtain information about a particular subject from the four corners of the world.

The choice of this line of guide is due to the fact that they capture general or complex concepts in particular and specific data for a given cause, it is thus possible to have an idea of the whole. Other writers such as [22] define these methods in a more explanatory way as: the deductive method seeks to explain the content studied, while the inductive expands the zone of knowledge as studied.

The procedure performed was content analysis, an active reflection of all data obtained, to achieve a synthetic and objective result about the analysis of recalques in cuttings using empirical methods.

It was necessary to use qualitative analysis that, "Qualitative research can be characterized as an attempt to understand a detailed understanding of the meanings and situational characteristics presented by the interviewees, in a place of the production of quantitative measures of characteristics or behavior".

The content analysis will be based on the understanding of the entire bibliography raised, with the notes of the most important points related to the analysis of recalques in cuttings using empirical methods.

IV. RESULTS AND DISCUSSION

To start an analysis of recalques in piles should start a geotechnical study, analyzing the reports of field surveys, and from this point on the study of the geotechnical massif of the soil is initiated, which provided the knowledge of soil layers, NSPT indices, groundwater level, soil identification and geological formation.

Associated with the recognition of the subsoil and its properties, it is necessary to analyze the load plant in order to identify the loads of the building the evaluation of the magnitude of the pillars, thus the geometric part of the project was initiated.

The analysis of the load plant and the lease of the pillars has an important role for the choice of the foundation employed, because from the shape and dimensions of the pillars, together with the report, the choice of the type of foundation is made and also through it it was succeeded in identifying and positioning each column, according to the calculation of influence in the determination of the drilling hole. Soon after, the identification of the soil and the loads transmitted therein, one can define the type of foundation type.

Then, the type of foundation must be defined and with the probing report, the determination of the load capacity of the soil and the length of the foundation, it is possible to use the semi-empirical methods: [13],[14] and [2].

For calculation using the Aoki Velloso Method, there is a variation according to the type of soil existing in each layer, and F1 and F2 varying according to the type of station. Stated by Kurt Amann's thesis that in the Brazilian geotechnical environment there are two classifications for the semi-empirical methods the "conservatives" and the "against safety" and presents according to summaries of scientific articles demonstrating the paradigm of classification of semi-empirical methods, results already expected for certain types of soils, in relation to semi-empirical methods, it shows that for soils of the type clay sand, clay and lateritic silt, in the region of São Paulo, and young residual, in the region of Goiás, presented better response with the Aoki Velloso method, that is, more resistant soils, considering it more conservative [23].

Décourt-Lent method uses parameters that vary depending on the soil and the type of the cutting, in this case, root. The C coefficient used varies according to each soil type and is a parameter for the calculation of the tip resistance. The method takes into account the stress referring to lateral friction, the mean value of NSPT along the stet. Whereas the NSPT ceiling to be considered in lateral friction should not exceed 50.

Furthermore, for the tip resistance are used mean values of the NSPT of the base layer of the tip of the cutting, of the immediately anterior and immediately posterior layer, and a maximum of 20% of the permissible load can be supported by the tip of the pile, for excavated piles [8].

According to Wiliam Bertuzzi, who analyzed load capacity for cuttings in sandy soils, it was observed that the semi-empirical method of Décourt-Quaresma presents better results. And also, as Kurt Amann's thesis provides a summary of scientific technical articles to demonstrate the paradigm of classification of semi-empirical methods, Annex D, demonstrates in places such as Belém, sandy soil and root cutting the best method was Décourt Quaresma, considered the most conservative, and also had good results

such as: sandy sediment, lateritic, porous clay and sandy clay [23].

V. FINAL CONSIDERATIONS

Based on the analysis of the results of the study carried out it can be concluded that to calculate the load capacity, based on the load test, the Aoki Velloso method can be considered effective, as they present values close to those found in the results of the assay. Also in this scenario, it is concluded that the Décourt-Quaresma method presents much lower values, characterizing itself as the least recommended method, for punctual study, due to the type of soil.

In view of the analyses performed in this study and the evaluated context, the results allow us to conclude that when using semi-empirical methods of estimating the recalque, soil characteristics should be carefully evaluated, especially in cases where the parameters used by them are obtained through semi-empirical correlations.

However, it is proven the influence that a recalque analysis can have on a foundation. That is, for geotechnical dimensioning, depending on the method used to estimate displacement and the parameters taken into account, a designer may overestimate the geometric characteristics of a foundation, or compromise the integrity, functioning and stability of a structure.

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Looper angle and looper tension control between roll stands in hot strip finishing mills in adaptive, predictive Proportional Integral (PI) and Inverse Linear Quadratic (ILQ) control modes, with activation by means of servo valves and hydraulic cylinders

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Keywords— Hot strip finishing mills, Looper angle and tension system, Adaptive and predictive control.

Abstract— In this article, the development of parameterization of the controller for looper control angle and tension in hot strip finishing mills is traced based on Inverse Linear Quadratic (ILQ) and Proportional Integral (PI) mode control, mainly considering, in the rolled material, thickness and width in the steel strip. Firstly, the ILQ mode approach is applied in the looper angle and looper tension, both calculated and compared with real conditions, to compensate disturbances and unmodeled dynamics in the looper, increasing or decreasing the angle position, through of Automatic Pressure Control (APC) as well as the speed reference in the previous stand rolling. Secondly, the Proportional Integral (PI) mode approach is applied in the looper angle e looper tension, where only looper angle is calculated and compared with the real condition and looper tension is calculated and applied in the open loop with use torque reference, to compensate disturbances and unmodeled dynamics in the looper. So, one set of ideal control parameters has been defined for the looper tension and looper angle, improving the performance of the overall system, always depending on the processed material, and thickness and width in the steel strip in the finishing mill. Simulation results show the effectiveness of the proposed controller compared with other methods that use only one control model for all steels' types.

I. INTRODUCTION

Hot milling is one of the main processes in steel mills in terms of quality, cost, and energy consumption to transform steel plates into hot strip coils. This process consists of eight main steps:

a- Storage of plates proceeding from the continuous casting process in the steel mill;

b- Plate reheating furnace, using natural gas, to achieve 1240°C;

c- Roughing mill, transforming steel plates with a thickness between 210-250 mm in steel roughing with a thickness between 20-40 mm and width between 750-2050 mm;

- d- Swing shears, moving cut of roughcasts to prepare the top and tail;
- e- Finishing mill, responsible for final product dimensions;
- f- Cooling table to obtain mechanical properties;

This work is supported by publication, the hot strip mill looper system in IEEE Transactions on Industry Applications e Looper-Tension almost disturbance decoupling control for hot strip finishing mill based on feedback linearization in IEEE Transactions on industrial electronics.

- g- Winders to roll the material in hot strip coils.
- h- Storage and cooling yard for the final hot coil product obtained.

During the continuous casting process, the thickness of the plates obtained is between 210-250 mm, and the plates are reheated to achieve an extraction temperature of 1240°C; then, the thickness is reduced by means of several passes in reversible mills and the width is reduced or stretched by the edge cylinders. At the end of the thinning process, the strip thickness is typically 20 to 40

mm and the strip width is between 750 to 2050 mm, with final temperature for processing at the finishing mill stage of approximately 1050°C. After the thinning process, the strips go through the swing shears cutting process as preparation before entering the six roll stands of the finishing mill. The purpose of the finishing mill is the additional thickness reduction, with production up to 1.2 to 25 mm, which are then cooled in the outfeed table down to temperatures of approximately 870°C, and finally rolled in the winders with a temperature of approximately 600°C. The hot coil, final product obtained in the process, can also be processed on a cold strip mill to obtain cold coils as the final product. In the finishing mill, an essential stage of the hot milling process, each roll stand is activated by an alternating current motor with speed controlled by an ASR (Automatic Speed Regulator). During the process of the finishing mill, process stability between roll stands is essential to ensure the dimensions, surface quality, and equipment availability. To allow this to happen, there are control systems between each pair of roll stands, as shown in Figure 1, in order to maintain upward pressure on the strip and ensure correct mass flow during the operation.

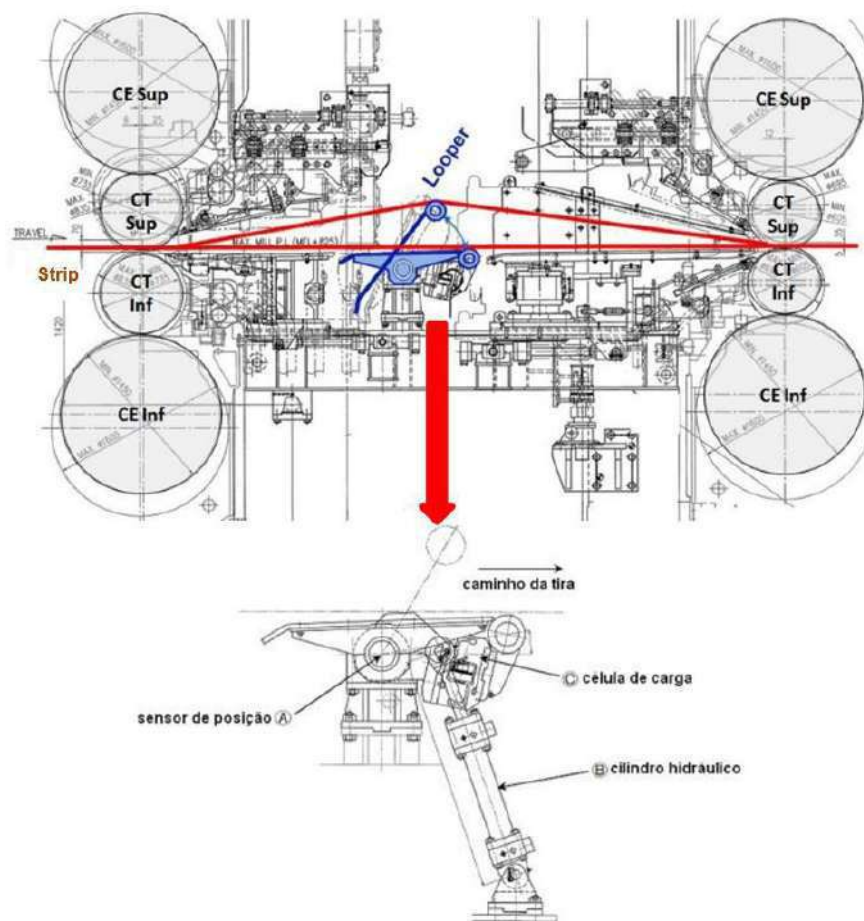


Fig.1: "Looper" and geometry between roll stands

This piece of equipment is the looper, and its movement causes strip length variations between roll stands to control mass flow imbalance and fluctuations, which are caused by four main reasons:

- a- Changes in the force imposed on the roll stands by means of the Automatic Gauge Control (ACG) system or automatic thickness control;
- b- Temperature heterogeneity along the strip length, from the finishing mill process or previous processes;
- c- Slippage caused by the difference in speed between the strip being milled and the work cylinders in the finishing mill;
- d- Changes in thickness and hardness along the strip caused by irregularities in the continuous casting process or chemical composition of the steel.

For example, in case of low strip tension between the finishing mill roll stands, the looper angle must be increased in order to increase the strip tension, as shown in Figure 2; in the opposite direction, in case of high tension between the finishing mill roll stands, the looper angle must be reduced, as shown in Figure 3, to reduce the strip tension [1]. Due to the changes in looper angle and torque, caused by changes in strip height and length between roll stands, the looper angle value must remain constant, creating a flexible system to absorb mass flow anomalies.

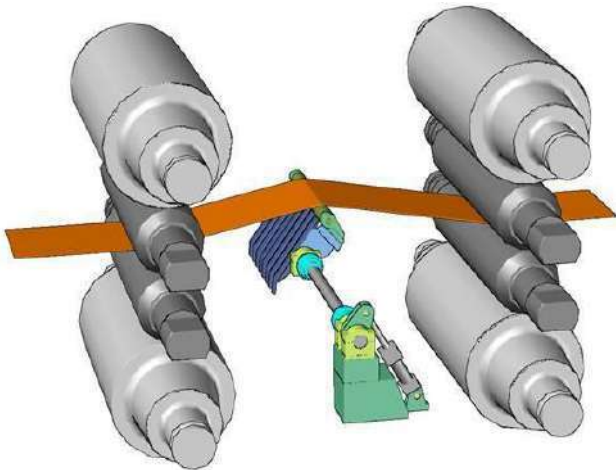


Fig.2: Increased looper angle due to low strip tension

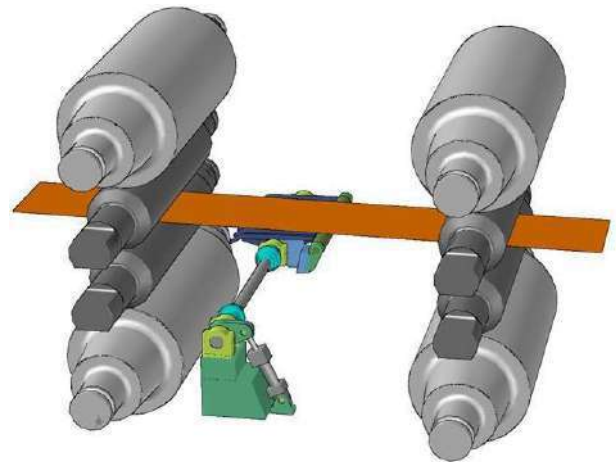


Fig.3: Reduced looper angle due to high strip tension

Perfect looper angle and torque control are critical factors to ensure strip quality and successful finishing mill operations. Due to factors such as parameter uncertainty and system disturbances of non-linear nature, looper angle and torque control are challenging projects. Some control modes are commonly used for such purposes:

- a- "Inverse Linear Quadratic" (ILQ) control mode, which uses the looper angle as the main variable;
- b- "Proportional Integral" (PI) control mode, conventional and not interactive, which uses the looper torque as the main variable [1];
- c- Robust and adaptive control mode [2];
- d- Excellent and multi-variable control [3];
- e- H-infinity control mode [4].

All modes are similar to linear models regarding the references received from the output system [5, 6, 7]. Due to the non-linear nature of the system and disturbances, the controllers execute a limited range of operation. To overcome this problem, some non-linear control techniques have been proposed [8, 9, 10, 11], in these articles, the use of non-linear control techniques is effective in a wider range of work situations, for example, full non-linear controller based on a non-linear recursive method [9]; Constants were defined to account for output feedback when there is not strip tension measurement available; this system works to reject the disturbance with adaptive feedback controllers, and the simulation and online results showed the effectiveness of the controller. However, since many finishing mills have advanced equipment to collect process variables, such as strip tension meters using load cells and pressure transmitters, the availability of torque measurements

provided feedback that could make the controller more efficient.

Innovative controllers, based on "Sliding Mode Control" (SMC) [8], improve the performance of standard "Proportional Integral" (PI) controllers in the presence of friction phenomena. Since the strength must be known and becomes a simple characteristic of non-linear control systems, simulation results showed it achieved better compensation due to disturbances caused by friction and unmodelled dynamics. The authors replaced the conventional "Proportional Integral" (PI) controller regarding looper angle by the "Sliding Mode Control" (SMC) system, while the strip tension circuit still uses the "Proportional Integral" (PI) controller. In this case, there is a shortage in the system of transitory performance and the strip speed causes disturbances that cannot be rejected effectively.

This article applies an adaptive feedback controller in the strip tension circuit, considering the product dimensional characteristics and types of steel being milled, combining the benefits of both techniques, looper angle and torque control, using finishing mill data, acting in a predictive fashion, and improving the system global performance. As a response to the control system, using the "ILQ" and "PI" control modes, which consider looper angle and torque as the main variables, changes in position by means of a hydraulic circuit using servo valves and hydraulic cylinders. Up to the implementation of the present study in USIMINAS Hot Strip Mill N°2 in Cubatão, the finishing mill used two control modes:

- a- "Inverse Linear Quadratic" (ILQ) control mode, which uses the looper angle as the main variable;
- b- "Proportional Integral" (PI) control mode, conventional and not interactive, which uses the looper torque as the main variable [1];

The relation between these modes was random and completely based on operator experience, causing disadvantages in the process:

- a- Occurrence of strip scrapping in the finishing mill process due to the incompatibility of the "setup" defined by the equipment operator;
- b- Constant interruptions due to scrapping, significantly reducing equipment availability;
- c- Product rework and deviations due to non-compliance with dimensional requirements;
- d- Increased processing costs;
- e- Hot strip OTIF reduction;

II. MAIN MILLED STRIP QUALITY DEFECTS AND IMPACTS ON PRODUCTION CAUSED BY INCORRECT LOOPER OPERATION

Incorrect looper operation during the mass flow imbalance of the strip milled between the roll stands of the finishing mill increases or reduces strip tension. This imbalance may be caused by four main reasons, as mentioned in item 1, and in this case, the finishing mill operator is not able to keep the system stable, resulting in quality defects and impacts on production.

2.1 Main milled strip quality defects due to incorrect looper operation

According to [3] [9], there are five (5) main strip quality defects:

- a- Reduction of strip width;
- b- Strip rupture;
- c- Strip bending;
- d- Strip stretching;
- e- Strip dimensional variations;

According to [3] [9], the main causes of the five milled strip quality defects due to incorrect looper operation are:

- a- The low tension of the milled strip between roll stands;

This condition increases the looper angle and consequently increases the strip height between roll stands, which causes steel strip bends and further milling of bent strips. When this situation occurs, the process must be interrupted and, in some cases, the milling cylinder neck breaks.

- b- High tension of the milled strip between roll stands;

This condition reduces the looper angle and consequently the strip height between roll stands, which stretches the material and causes strip rupture between roll stands, interrupting the process and in some cases requiring either the work or rest milling cylinders to be changed due to incrustations or surface defects.

2.2 Impacts on production caused by incorrect looper operation

Incorrect looper operation causes four (4) main losses in the milling process:

- a- Effective use of equipment, reducing availability;
- b- Product rework and deviations due to non-compliance with customer specifications;

- c- Constant rework and interruptions increase processing costs;
- d- Non-compliance with customer quantities and deadlines (On Time In Full - OTIF).

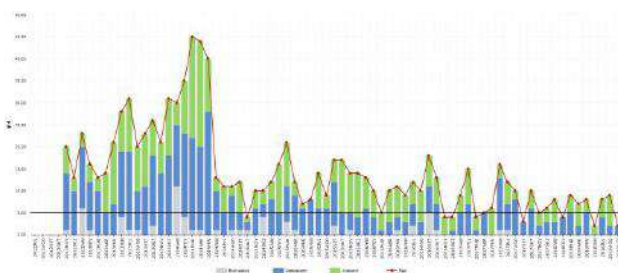
2.2.1 Effective use of equipment

The effective use of equipment is the percentage of time in which the equipment effectively performed its function, considering emergency downtime and excluding scheduled downtime, either for operation, maintenance, or for other reasons.

Since September of 2015, for a period of two years, the effective use has always been below the goal of 80%, in the USIMINAS Hot Strip Mill No. 2 in Cubatão, with rare exceptions over the years, as shown in Figure 4. The main reasons why the hot strip mill did not meet the desired effective use were operational emergencies, with the main cause being finishing mill scrapping, which were above 5/month, with total average scrapping of 10/month, as shown in Figure 5.



*Fig.4: Effective use of Hot Strip Mill No. 2
Cubatão – USIMINAS*



*Fig.5: Occurrence of scrapping by location in Hot Strip
Mill No. 2 Cubatão – USIMINAS*

2.2.2 Product rework and deviations

The loss of material produced in specific pieces of equipment occurs in case of non-compliance of requirements specified by the customer and is known as rework or deviations.

2.2.2.1 Material deviations

The deviation indexes, also known as loss of material, presented the following monthly averages in respect to

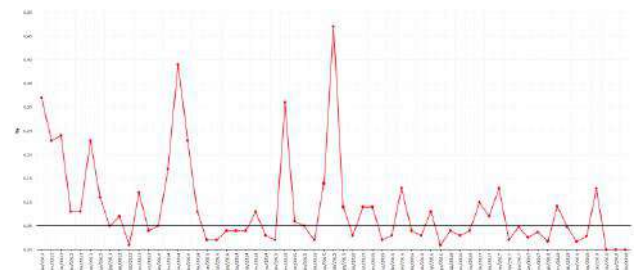
the total production of hot coils in Hot Strip Mill No. 2, for the following defects:

- a- Incorrect width (smaller): More than 0.05% according to distribution over the years is shown in Figure 6;
- b- Incorrect width (bigger): More than 0.15% according to distribution over the years is shown in Figure 7;

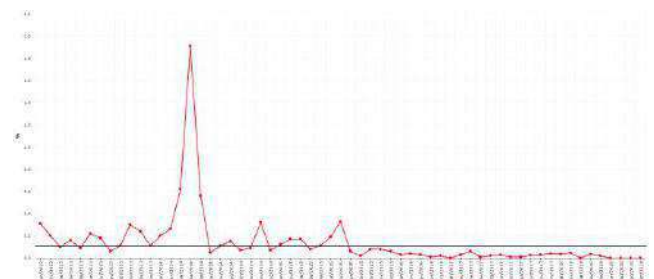
Incorrect width, either smaller or bigger, in respect to the nominal width defined on the customer order, occurs due to strip tension irregularities between finishing mill roll stands, as described in item 2.1 herein.

- c- Thickness change: More than 0.10% according to distribution over the years is shown in Figure 8.

Thickness changes always occur after emergency downtime to remove scraps, either on the finishing mill, roughing mill, or winder. The long time required to normalize the equipment and change the work cylinders after removing scraps, mainly in the finishing mill, affects the discharge rhythm of the plate-reheating furnace and eliminates the thermal crowning of the work cylinders, requiring a new milling sequence to achieve the work cylinder thermal characteristics required, as well as plate discharge rhythm of the furnace.



*Fig.6: Incorrect width (smaller) stoppage percentage in
Hot Strip Mill No. 2 – Cubatão – USIMINAS*



*Fig.7: Incorrect width (bigger) stoppage percentage in
Hot Strip Mill No. 2 – Cubatão – USIMINAS*



Fig.8: Thickness change stoppage percentage in Hot Strip Mill No. 2 – Cubatão – USIMINAS

2.2.2.2 Material rework

The rework indexes, also known as material rework, presented the following monthly averages in respect to the total production of hot coils in Hot Strip Mill No. 2, for the following defects:

- a- Incorrect width (smaller): More than 0.20% according to distribution over the years is shown in Figure 9;
- b- Incorrect width (bigger): More than 0.10% according to distribution over the years is shown in Figure 10;

The defective region of hot finishing lines must be scrapped, after the hot milling process, normally a dividing line that, in concept, besides tending to rework, divides the product within the weight range defined by the customer, using this additional process route, in cases that require rework, increasing production costs, in order to deliver the product according to the dimensions defined in the customer order.



Fig.9: Incorrect width (smaller) rework percentage in Hot Strip Mill No. 2 – Cubatão – USIMINAS

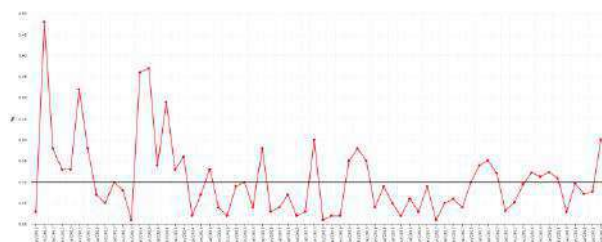


Fig.10: Incorrect width (bigger) rework percentage in Hot Strip Mill No. 2 – Cubatão – USIMINAS

2.2.3 Increased processing costs

The processing cost is defined as the total cost obtained when processing steel plates into hot coils, by means of the milling process.

The target processing cost for Hot Strip Mill No. 2 in Cubatão was US\$50/t.

The results obtained over the months in 2016 and 2017 were higher than the target, as shown in Figures 11 and 12.

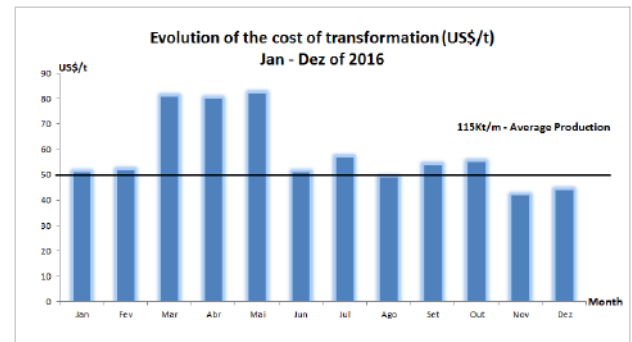


Fig.11: 2016 processing cost performance in Hot Strip Mill No. 2 – Cubatão – USIMINAS

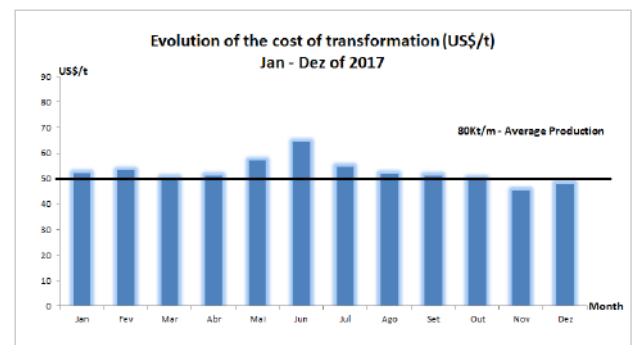


Fig.12: 2017 processing cost performance in Hot Strip Mill No. 2 – Cubatão – USIMINAS

2.2.4 OTIF

The on time in full performance for hot coils in Hot Strip Mill No. 2 in Cubatão was lower than 60%, far from the minimum target of 80%, as shown in Figure 13.

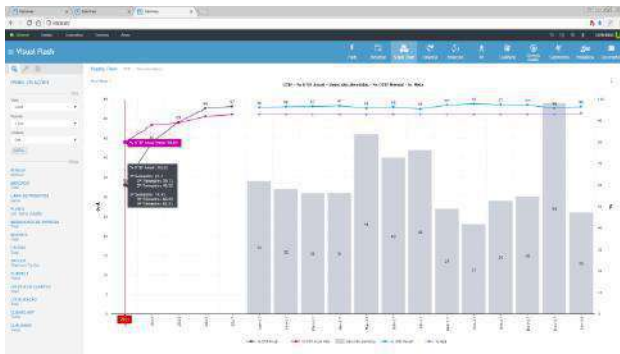


Fig.13: OTIF (On Time In Full) performance over the last 5 years in Hot Strip Mill N° 2 – Cubatão - USIMINAS

III. STEEL STRIP TENSION DYNAMIC AND STATIC MODEL USING LOOPER TORQUE AND ANGLE ACTIVE BY A SERVO VALVE

The PI and ILQ parameters are adjusted based on the steel strip tension defined and looper angle obtained in the dynamic and static model. The looper geometric relations are shown in Figure 14, and the respective nomenclatures are presented in Table 1.

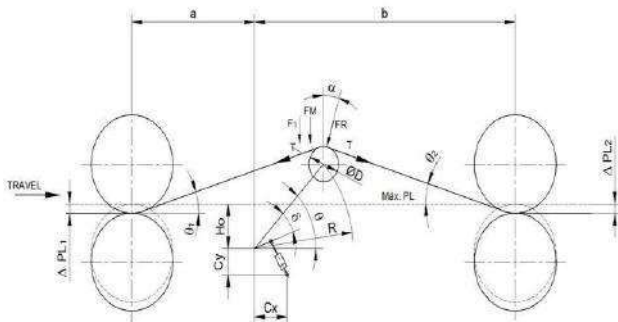


Fig.14: "Looper" and geometry between roll stands

Table 1 – "Looper" and roll stand geometry nomenclature

Symbol	Unit	Description
T	Kg	Strip tension
FS	Kg	Strip weight
FM	Kg	Bending strength
R	mm	Looper arm length
H ₀	mm	Looper axial center ~ maximum distance to the pass line
H ₀₁ , H ₀₂	mm	Looper axial center ~ expected position to pass line
ΔPL ₁ , ΔPL ₂	mm	Difference between maximum and expected position to pass line
D	mm	Looper roll diameter
Ut	Kg/mm	Tension unit
W	mm	Strip width
t	mm	Strip thickness
ρ	Kg/mm ³	Strip density
θ	Degrees	Looper angle
θ ₀	Degrees	Load cell adjustment angle
δ	Degrees	Angle between the looper arm and lever
C _x , C _y	mm	Distance from the looper joint and cylinder joint

3.1 Strip tension calculation

The strip tension can be calculated according to the looper cylinder force. The cylinder force is detected by the pressure transducers installed in the cylinder piston and stem side cavities. The transducers calculate the tension and use it to control the looper angle. The tension calculated by the pressure load cell is used as a backup or for viewing purposes.

3.1.1 Calculation with pressureatransducer

$$T_L = T_R - J \frac{d\omega}{dt} \quad (1)$$

$$T_R = T_{LP} = I_2 \cdot F_L \cos\left(\frac{\pi}{2} - \gamma - \psi\right) \quad (2)$$

Where equation 1 describes:

T_L: Looper load torque [Nm]

T_R: Torque caused by the cylinder force [Nm]

J: Looper moment of inertia + Cylinder inertia [Nm²]

ω: Looper angular speed [rad/s]

The looper load torque is considered as the total torque by means of four torque components:

3.1.1.1 Torque due to strip tension:

$$f_3 = (\theta)A\sigma \quad (3)$$

$$f_3(\theta) = R_1 \{ \sin(\theta + \beta) - \sin(\theta - \alpha) \} \quad (4)$$

A: strip cross section (mm²)

σ: strip unit tension (Mpa)

3.1.1.2 Torque due to strip weight:

$$f_4(\theta) \quad (5)$$

$$C = gR_1 \frac{W_s}{2} \cos \theta \quad (6)$$

3.1.1.3 Torque due to looper weight:

$$f_5(\theta) \quad (7)$$

$$f_5(\theta) = gR_G W_L \cos \theta \quad (8)$$

3.1.1.4 Torque due to strip bending:

$$f_6(\theta) \quad (9)$$

$$f_6(\theta) = \frac{4E}{L^3} wh^3 (R_1 \sin \theta - H_1 - R_2) R_1 \cos \theta \quad (10)$$

Where:

$$\alpha = \tan^{-1} \frac{R_1 \sin \theta - H_1 - R_2}{L_1 + R_1 \cos \theta} \text{ (rad)} \quad (11)$$

$$\beta = \tan^{-1} \frac{R_1 \sin \theta - H_1 - R_2}{L - L_1 + R_1 \cos \theta} \text{ (rad)} \quad (12)$$

$$W_s = \rho WhL \cdot 10^{-9} \text{ (Kg)} \quad (13)$$

$$T_L = f_3 A \sigma + f_4(\theta) + f_5(\theta) + f_6(\theta) \quad (14)$$

Therefore, equation 15,

$$\sigma = \frac{T_L - (f_4(\theta) + f_5(\theta) + f_6(\theta))}{f_3(\theta) A} \text{ (Mpa)} \quad (15)$$

3.1.2 Calculation with a load cell

$$F_T = 2T \sin \frac{\alpha + \beta}{2} \quad (16)$$

$$F_S = g \cdot \frac{W_s}{2} \quad (17)$$

$$F_B = \frac{4EWh^3 (R_1 \sin \theta - H_1 + R_2)}{L^3} \quad (18)$$

Where:

F_T : Strip tension [N]

F_S : Strip weight [N]

T : Total tension [N]

F_B : Torque due to strip bending:

$$\alpha = \tan^{-1} \frac{H}{L_1 + L_2} \text{ (rad)} \quad (19)$$

Where:

$$\beta = \tan^{-1} \frac{H}{L - (L_1 + L_2)} \text{ (rad)} \quad (20)$$

$$L_2 = R_1 \cos \theta \quad (21)$$

$$H = R_1 \sin \theta + R_2 - H_1 \quad (22)$$

$$W_s = \rho WhL \quad (23)$$

Where:

W : Strip width, exit from previous roll stand (mm)

h : Strip thickness, exit from previous roll stand (mm)

ρ : Steel specific weight (kg/mm³)

δ : Load cell angle (20°C)

The force calculated by the load cell is found using the following equation:

$$F_{LC}^L = F_{OP}^L + F_{DR}^L = (F_T + F_S + F_B) \cdot \cos(\theta - \delta) + F_L \quad (24)$$

Where:

$$F_T = \frac{F_{LC} - F_L}{\cos(\theta - \delta)} - (F_S + F_B) \quad (25)$$

$$T = \frac{F_T}{2 \sin(\frac{\alpha + \beta}{2})} - (F_S + F_B) \quad (26)$$

$$\sigma = \frac{T}{(Wh)} \text{ (Mpa)} \quad (27)$$

3.2 Looper model

Applying Newton's Law of movements for the looper, we have the equations and variables presented in Table 2:

$$S = \frac{(C_Y + L_C) \cdot \sin(\theta - \delta)}{\cos(\emptyset)} - L_C \quad (28)$$

$$\theta = \sin^{-1} \left[\frac{L_3 \cdot \cos(\emptyset) - C_Y}{L_C} \right] - \delta \quad (29)$$

$$\emptyset = \tan^{-1} \left[\frac{(C_X - L_C) \cdot \cos(\theta - \delta)}{(C_Y + L_C) \cdot \sin(\theta - \delta)} \right] \quad (30)$$

$$\emptyset = \theta_2 - \theta_3 \quad (31)$$

$$\theta_2 = \tan^{-1} \left(\frac{C_X}{C_Y} \right) \quad (32)$$

$$\theta_3 = \cos^{-1} \left(\frac{L_4^2 + L_3^2 - L_C^2}{2 \cdot L_4 \cdot L_3} \right) \quad (33)$$

Table 2 – “Looper” dynamics nomenclature

Symbol	Unit	Description	Roll Stand 1 a 3	Roll Stand 4 a 5
θ	degrees	Looper angle	6,4° ~ 71,9°	6,4° ~ 71,9°
S	mm	Cylinder stroke	10 ~ 410	39,9 ~ 335,8
L_o	mm	Looper height	-44 ~ 469	-44 ~ 469
X1	mm	Cylinder shackle center on the Y axis	$X1 = L_c \cdot \sin(\theta - \delta)$	
X2	mm	Cylinder shackle center on the X axis	$X2 = L_c \cdot \cos(\theta - \delta)$	
ϕ	degrees	Cylinder movement angle	$\phi = \theta_2 - \theta_3$	
L_s	mm	Cylinder shackle	$L_s = L_o + S$	
L_c	mm	Cylinder shackle center	1260,5	1260,5
L_o	mm	Cylinder in backward position	1111	1140,9
Cy	mm	Cylinder shackle center on the Y axis	1080	1080
Cx	mm	Cylinder shackle center on the X axis	650	650
Lc	mm	Cylinder lever length	385	280
R	mm	Arm length	612	612
δ	degrees	Arm angle	6,58°	6,58°
H_o	mm	Maximum pass line in the Y axis	205	205
D	mm	Looper roll diameter	185	185

3.2.1 Force received from the strip on the looper

For the dynamic “looper” load equations, the systems are according to equations 34 to 42 and Table 1, according to introduction of item 3:

$$FR = 2 \cdot T \cdot \sin \left[\frac{(\theta_1 + \theta_2)}{2} \right] + FS \cdot \cos \alpha + FM \cdot \cos \alpha \quad (34)$$

$$\theta_1 = \tan^{-1} \left[\frac{R \cdot \sin \theta - \left(H_{o1} + \frac{D}{2} \right)}{a + R \cdot \cos \theta} \right] \quad (35)$$

$$\theta_2 = \tan^{-1} \left[\frac{R \cdot \sin \theta - \left(H_{o2} + \frac{D}{2} \right)}{b + R \cdot \cos \theta} \right] \quad (36)$$

$$H_{o1} = H_o - \Delta PL_1 \quad (37)$$

$$H_{o2} = H_o - \Delta PL_2 \quad (38)$$

$$\alpha = \frac{\theta_2 - \theta_1}{2} \quad (39)$$

$$T = Ut \cdot W \cdot t \quad (40)$$

$$FS = \frac{1}{2} \cdot \rho \cdot (a + b) \cdot W \cdot t \quad (41)$$

$$FM = \frac{4 \cdot E \cdot W \cdot t^3 \left[R \cdot \sin \theta - \left(H_{o2} + \frac{D}{2} \right) \right]}{(a + b)^3} \quad (42)$$

3.2.2 Force received from the strip on the load cell

$$FL = \frac{FR}{2} \cdot \cos(\theta + \theta_o + \alpha) \quad (43)$$

3.2.3 Force received from the "looper"

$$FR = \frac{F_{CY} \cdot L_c \cdot \cos \theta \cdot cy - W_G \cdot \cos(\theta_G + \theta) \cdot L}{R \cdot \cos(\theta + \alpha) + V_{OFF}} \quad (44)$$

$$\theta_{CY} = \emptyset - \theta + \delta - acerto \pm 1^\circ \text{ ou menos} \quad (45)$$

3.2.4 Force received from the hydraulic cylinder

$$PH = \frac{F_{CY} + PR \cdot AR}{AH} \quad (46)$$

3.3 Unmodeled disturbances and dynamics

There are several sources of disturbances and dynamics that affect the looper system and strip tension. The main disturbance of the strip tension circuit comes from changes in mass flow caused by the quick action of the ACY (Automatic Gauge Control) system. Another disturbance is finishing mill setup incompatibility, which creates constant disruption. In addition, forward and backward sliding, which is influenced by tension over time, is uncertain. Therefore, strip rated speed errors of 5% are frequently found. Regarding the looper angle, the unmodelled disturbances and dynamics come from vicious friction on the hydraulic cylinder, looper torque for strip bending, and so forth.

3.4 Looper hydraulic systems with cylinder controlled by a servo valve

The principle of the hydraulic looper is based on the displacement of a cylinder actuated by a four-way, three position servo valve, the principle is illustrated in Figure 5.

The hydraulic cylinder piston side is connected to a servo valve port A, and the hydraulic cylinder stem side is connected to a servo valve port B; the piston side pressure is indicated by P_{pst} and the stem side pressure is indicated by P_{rod} ; the system pressure is indicated by P_{sys} and the oil return pressure is indicated by P_{tnk} ; the cross-section areas of both sides of the hydraulic cylinder are indicated by A_{pst} and A_{rod} , and the internal and external discharge coefficient is represented by C_{in} and C_{ex} respectively; the hydraulic cylinder displacement is represented by y , and the kinematic viscosity coefficient is indicated by ν ; the elastic resistance coefficient is indicated by G , and the load force is indicated by F_{ld} ; the

hydraulic cylinder equivalent mass and load is indicated by M , and the hydraulic oil bulk module is indicated by B_e .

There are three (3) types of oil flows in hydraulic cylinder systems controlled by servo valves, namely[12] [13] [14] [15]:

- a- Hydraulic cylinder dynamic flow;
- b- Servo valve specific flow;
- c- Flow between the servo valve and the hydraulic cylinder.

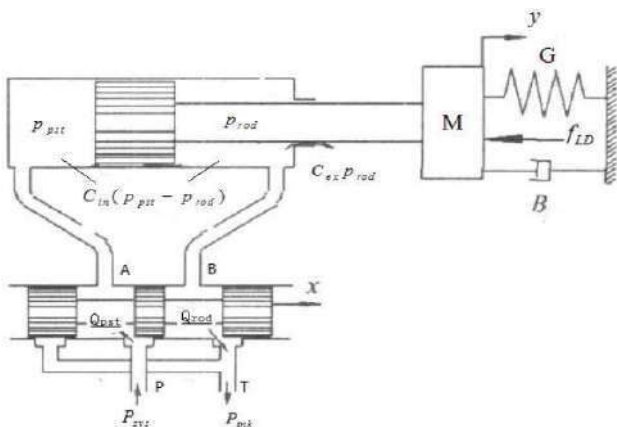


Fig.5: Hydraulic cylinder assembly activated by a servo valve

3.4.1 Analysis of the hydraulic cylinder dynamic flow

Hydraulic cylinder systems controlled by dynamic valves include pressure changes, piston movement, and flow changes caused by cavity leakage. In hydraulic cylinder systems controlled by servo valves, the flow changes for both hydraulic cylinder cavities are different.

The analysis process specifies and considers the following:

3.4.1.1 Additional flow caused by pressure changes

In the analysis process of the dynamic response of hydraulic cylinders controlled by a servo valve, oil compressibility cannot be overlooked. The relation between the addition flow for both cavities, caused by oil pressure and volume changes, is determined by means of the following equation:

$$Q_{Vpst} = \frac{V_{pst}}{B_o} \cdot \frac{dp_{pst}}{dt} \quad (47)$$

$$Q_{Vrod} = \frac{V_{rod}}{B_e} \cdot \frac{dp_{rod}}{dt} \quad (48)$$

3.4.1.2 Additional flow caused by piston displacement

The additional flow $Q_{y_{pst}}$ and $Q_{y_{rod}}$ for two cylinder cavities during displacement is determined by means of the following equations:

$$Q_{Ypst} = A_{pst} \cdot \frac{d_y}{d_t} \quad (49)$$

$$Q_{Yrod} = -A_{rod} \cdot \frac{d_y}{d_t} \quad (50)$$

3.4.1.3 Additional flow caused by leakage

The additional flows Q_{xpst} and Q_{xrod} for both cylinder cavities caused by leakage are directly related to their pressures. The total flow for each cavity is determined by means of the following equations:

$$Q_{xpst} = C_{in} \cdot (p_{pst} - p_{rod}) + C_{ex} \cdot p_{pst} \quad (51)$$

$$Q_{xrod} = C_{in} \cdot (p_{rod} - p_{vst}) + C_{ex} \cdot p_{rod} \quad (52)$$

3.4.2 Analysis of the servo valve characteristic flow

3.4.2.1 Analysis of the servo valve characteristic static flow

The characteristic flow of servo valves is described by the drop in nominal pressure Δp_n , nominal flow Q_n , and the frequency response characteristic curve. When the valve pressure drop is Δp_n , the relation between the valve actual flow and nominal flow is determined by the following equation:

$$Q(x, \Delta_{pl}) = x \cdot Q_n \cdot \sqrt{\frac{\Delta P_l}{\Delta P_n}} \quad (53)$$

3.4.2.2 Linearization of the servo valve characteristic static flow

The servo valve operates close to zero in respect to the opening angle, and by the linearization of the characteristic flow process, we obtain the following equation:

$$Q = K_g \cdot x - K_c \cdot \Delta P_L \quad (54)$$

In the equation above K_q , the servo valve flow gain coefficient is the pressure flow coefficient. According to the servo valve flow characteristics equation, the flow gain coefficient is different and shows variation at each change in direction and opening in degrees.

When > 0 ,

$$K_{q\text{ pst}+} = Q_N \cdot \sqrt{\frac{P_{\text{sys}} - P_{\text{pst}.0}}{\Delta P_N}} \quad (55)$$

$$K_{q\text{ rod}} = Q_N \cdot \sqrt{\frac{P_{\text{rod}.0} - P_{\text{tnk}}}{\Delta P_N}} \quad (56)$$

When < 0 ,

$$K_{q\text{ pst}-} = Q_N \cdot \sqrt{\frac{P_{\text{pst}.0} - P_{\text{tnk}}}{\Delta P_N}} \quad (57)$$

$$K_{q\text{ rod}-} = Q_N \cdot \sqrt{\frac{P_{\text{sys}} - P_{\text{rod}.0}}{\Delta P_N}} \quad (58)$$

Where, $P_{\text{pst}.0}$ e $P_{\text{rod}.0}$ are, respectively, the cavity static work point pressures piston side and stem side cavity. We can see that the flow gain coefficient involves four (4) parameters: $K_{q\text{ pst}}$, $K_{q\text{ rod}}$, $K_{q\text{ pst}-}$ and $K_{q\text{ rod}-}$; similar to the situation of the pressure flow coefficient K_c , which make it difficult to analyze the model.

3.4.2.3 Servo valve dynamic characteristics

The actual opening X and the programmed opening of servo valves are not exactly the same, and can be described according to oscillation of two orders:

$$G_{vlv}(S) = \frac{1}{\left(\left(\frac{s}{W_v}\right)^2 + \frac{2\partial_v S}{W_v} + 1\right)} \quad (59)$$

Where W_v is the servo valve cut frequency, ∂_v is the valve core-opening coefficient.

3.4.3 Analysis of the flow between the servo valve and the hydraulic cylinder

Using the oil from each hydraulic cylinder cavity as object of research, the flow equation can be defined according to the oil continuity inside and outside the cavity.

For the piston side cavity,

$$Q_{\text{pst}}(t) = Q_{v\text{pst}} + Q_{y\text{pst}} + Q_{x\text{pst}} \quad (60)$$

$$= A_{\text{pst}} \cdot \frac{dy}{dt} + \frac{V_{\text{pst}}}{\beta_e} \cdot \frac{dp_{\text{pst}}}{dt} + C_{\text{in}} \cdot (P_{\text{pst}} - P_{\text{rod}}) + C_{\text{ex}} \cdot P_{\text{pst}} \quad (61)$$

In the form of transference function,

$$P_{\text{pst}}(S) = G_{\text{pst}}(S) \cdot (Q_{\text{pst}} - A_{\text{pst}} \cdot sy + C_{\text{in}} \cdot P_{\text{rod}}) \quad (62)$$

Where,

$$G_{\text{pst}}(S) = \frac{1}{\left(\frac{V_{\text{pst}}}{\beta_e} S + C_{\text{in}} + C_{\text{ex}}\right)} \quad (63)$$

Likewise, for the stem side cavity,

$$Q_{\text{rod}}(t) = Q_{v\text{rod}} + Q_{y\text{rod}} + Q_{x\text{rod}} \quad (64)$$

$$= -A_{\text{rod}} \cdot \frac{dy}{dt} + \frac{V_{\text{rod}}}{\beta_e} \cdot \frac{dp_{\text{rod}}}{dt} + C_{\text{in}} \cdot (P_{\text{rod}} - P_{\text{pst}}) + C_{\text{ex}} \cdot P_{\text{rod}} \quad (65)$$

In the form of transference function,

$$P_{\text{rod}}(S) = G_{\text{rod}}(S) \cdot (Q_{\text{rod}} - A_{\text{rod}} \cdot sy + C_{\text{in}} \cdot P_{\text{pst}}) \quad (66)$$

Where,

$$G_{\text{rod}}(S) = \frac{1}{\left(\frac{V_{\text{rod}}}{\beta_e} S + C_{\text{in}} + C_{\text{ex}}\right)} \quad (67)$$

3.4.4 Hydraulic cylinder movement equation

In the hydraulic cylinder control valve, as shown in Figure 2, according to the mechanics of Newton's Law, the hydraulic cylinder movement equation is as follows:

$$A_{\text{pst}} P_{\text{pst}} - A_{\text{rod}} P_{\text{rod}} = M \frac{d^2 y}{dt^2} + B \frac{dy}{dt} + Gy + f_{Ld} \quad (68)$$

In the form of transference function,

$$y(S) = G_{\text{cyd}}(S) \cdot (A_{\text{pst}} \cdot P_{\text{pst}}(s) - A_{\text{rod}} \cdot P_{\text{rod}}(s) - f_{Ld}) \quad (69)$$

Where,

$$G_{\text{cyd}}(S) = \frac{1}{(MS^2 + BS + G)} \quad (70)$$

3.5 Model of hydraulic cylinder controlled by a servo valve

3.5.1 Analysis of the static work point

The servo valve characteristic dynamic flow is always related to work point specifications, so the static work point of the hydraulic cylinder system controlled by a servo valve must be analyzed. In hydraulic cylinder systems controlled by a servo valve, as shown in Figure 5, the hydraulic cylinder must meet the following conditions to keep stationary.

3.5.1.1 Force balancing equation

When the hydraulic cylinder maintains uniform or stationary movement, the total output force of both cavities is balanced with the load.

$$A_{pst} \cdot p_{pst} - A_{rod} \cdot p_{rod} = f_{Ld} \quad (71)$$

The formula below is obtained when both sides of the formula above are divided by A_{rod} .

$$p_{pst} = \frac{(p_{rod} + P_{Ld})}{\varphi} \quad (72)$$

In formula, $\varphi = \frac{A_{pst}}{A_{rod}}$, $P_{Ld} = \frac{f_{Ld}}{A_{rod}}$

Obviously, the force balancing equation is a group of parallel lines for different loads P_{Ld} .

3.5.1.2 Flow balancing equation

When the hydraulic cylinder is in uniform motion or stationary, not only the relation between the forces is maintained, but the hydraulic oil flow to the cavities also becomes proportional to the hydraulic cylinder cross-section. In other words, the hydraulic cylinder cannot move smoothly. When the cylinder stem moves in different directions, the oil path is different.

3.5.1.2.1 Hydraulic cylinder uniform forward movement

In this case, the servo valve-opening angle is $x > 0$ and the hydraulic oil flow through openings P and A of the servo valve in the hydraulic cylinder piston side cavity. The hydraulic oil flow in the stem side cavity is through openings B and T of the servo valve, returning to the hydraulic oil reservoir and expanding. According to the equations:

$$A_{pst} \cdot v^+ = Q_{pst} = Q_N \cdot \sqrt{\frac{P_{sys} - p_{pst}}{\Delta P_N}} \quad (73)$$

$$A_{rod} \cdot v^+ = Q_{rod} = Q_N \cdot \sqrt{\frac{P_{rod} - p_{tnk}}{\Delta P_N}} \quad (74)$$

We can, therefore, deduce that

$$p_{pst} = P_{sys} - \varphi^2 (P_{rod} - P_{tnk}) \quad (75)$$

In the formula, v^+ is the hydraulic cylinder movement speed; the following results are obtained considering equations (72) and (75).

$$P_{rod} = \frac{\varphi^3 \cdot P_{tnk} + \varphi \cdot P_{sys} - P_{Ld}}{\varphi^3 + 1} \triangleq P_{rod.0^+} \quad (76)$$

3.5.1.2.2 Hydraulic cylinder uniform return

In this case, the servo valve-opening angle is $x < 0$ and the hydraulic oil flow through openings P and B of the servo valve in the hydraulic cylinder stem side cavity. The hydraulic oil flow in the piston side cavity is through opening A e T of the servo valve, returning to the hydraulic oil reservoir and retracting. According to the equations:

$$p_{pst} = P_{tnk} - \varphi^2 (P_{sys} - P_{rod}) \quad (77)$$

The following results are obtained considering formulas (72) and (77).

$$P_{rod} = \frac{\varphi^3 \cdot P_{sys} + \varphi \cdot P_{tnk} - P_{Ld}}{\varphi^3 + 1} \triangleq P_{rod.0^-} \quad (78)$$

From the analysis demonstrated in section 4, we know that when the hydraulic cylinder moves constantly in different directions, in general pressures $P_{rod.0^+}$ or $P_{rod.0^-}$ on the stem side are not the same. The force balance equation and the flow balance equation are plotted in a plane coordinate system, as shown in Figure 6.

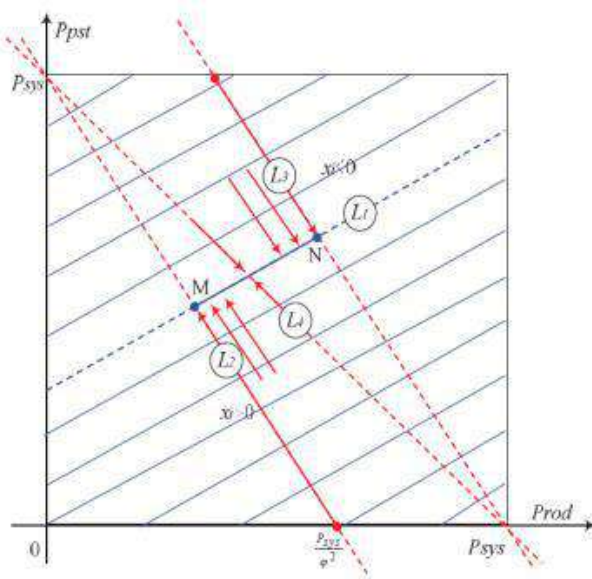


Fig.6: Static work points of hydraulic cylinders controlled by servo valves

As shown in Figure 6, the force balancing equation is represented by straight line L_1 , since the cavity pressure value is positive, and is restricted to the shaded region of the graphic. Flow equations L_2 , L_3 and force balancing equation L_1 have two intersection points: M and N. The analysis shows that $P_{rod,0}$ is higher than $P_{rod,0+}$, and point N is the system stable work point.

3.5.1.2.3 Symmetrical cylinder static work point

For symmetrical hydraulic cylinders with the same cross section, if the cylinder moves forwards or backward, the flow equations are the same.

$$p_{pst} = -p_{rod} + P_{sys} + P_{tnk} \quad (79)$$

The following results were obtained considering equations (72) and (79).

$$P_{rod,0} = \frac{P_{sys} + P_{tnk} - P_{Ld}}{2} \quad (80)$$

This shows that symmetrical cylinders have only one work point, which is equivalent to work points M and N of asymmetrical cylinders. According to the analysis in section 3.2, for symmetrical cylinder control valves, the flow gain coefficients for both sides of the cavity are always the same.

$$K_{q\,pst+} = K_{q\,rod+} + Q_N \cdot \sqrt{\frac{P_{sys} - P_{tnk} - P_{Ld}}{2 \cdot \Delta P_N}} \quad (81)$$

$$K_{q\,pst-} = K_{q\,rod-} - Q_N \cdot \sqrt{\frac{P_{sys} - P_{tnk} + P_{Ld}}{2 \cdot \Delta P_N}} \quad (82)$$

The equations above demonstrate that when we calculate the load flow characteristics of symmetrical hydraulic cylinders controlled by a servo valve, both cavities of the symmetrical cylinder are equivalent to one cavity, the total pressure drop of the servo valve port is the sum of the pressure drops in both servo valve openings.

3.5.2 Modeling of dynamic characteristics

In summary, the dynamic mathematical model of hydraulic cylinder systems controlled by servo valves can be obtained by means of the connection between the state variables of such systems according to the logical relationship of equations (6), (9), (11), (14), (17), as well as the demonstration in Figure 7. In Figure 7, the upper half segment reflects the piston's side cavity flow characteristics, and the lower half segment reflects the stem side cavity flow characteristics; the movement of the hydraulic cylinder connects them and some related coupling is caused by the hydraulic cylinder internal leakage.

As mentioned in section 3.2, the servo valve coefficients K_q and K_c are closely related to x (> 0 or < 0), and therefore the model shown in Figure 7 is still not a non-linear system and its dynamic and static characteristics cannot be analyzed intuitively and quantitatively, so the equivalent form of the model must be analyzed.

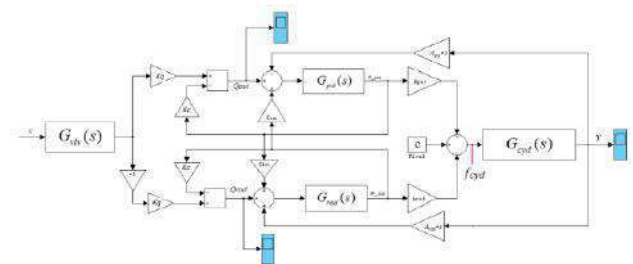


Fig.7: Dynamic model of hydraulic cylinders controlled by servo valves with a hydraulic looper

Under normal circumstances, the internal leakage coefficient C_{in} of hydraulic cylinders is very small, and both cavities create a coupling relation solely due to the movement of the hydraulic cylinder, after ignoring the leakage. The model can be simplified; the relationship between the total output force f_{cyd} of the hydraulic cylinder and the servo valve x and displacement data are as follows:

$$f_{cyd}(s) = x \cdot \left(\frac{K_{qpst} \cdot A_{pst}}{\frac{v_{pst}}{\beta_e} s + C_{ex} + K_{cpst}} + \frac{K_{qrod} \cdot A_{rod}}{\frac{v_{rod}}{\beta_e} s + C_{ex} + K_{crod}} \right) - sy \cdot \left(\frac{A_{pst}^2}{\frac{v_{pst}}{\beta_e} s + C_{ex} + K_{cpst}} + \frac{A_{rod}^2}{\frac{v_{rod}}{\beta_e} s + C_{ex} + K_{crod}} \right) \quad (83)$$

$$\triangleq x \cdot G_x(s) - sy \cdot G_y(s)$$

Equations $G_x(s)$ and $G_y(s)$ consist of two neutral elements. For symmetrical cylinder control valves, valve coefficients K_q and K_c for both cavities are always the same, and the two neutral elements are reduced to a single element. For asymmetrical cylinder control valves, the valve coefficients for both cavities are the same. This can be approximated by the inertia element [10]. The simplified model uses a symmetrical or asymmetrical cylinder, as shown in Figure 8.

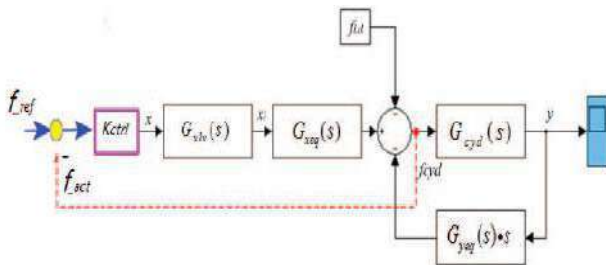


Fig.8: Simplified equivalent model of hydraulic cylinders controlled by servo valves

The closed loop control forces can be composed by introducing feedback on the hydraulic cylinder output, as shown in Figure 9, where K_{ctrl} is the closed loop force controller. Using the equivalent simplified model, the relationship between the excitation given $x(s)$ and the open loop transference function $G_{xf-op}(s)$ of the output force $f_{cyd}(s)$ is as follows:

$$G_{xf-op}(s) = \frac{f_{cyd}(s)}{x(s)} = \frac{G_{vlv}(s) \cdot G_{xeq}(s)}{1 + G_{vlv}(s) \cdot G_{xeq}(s) \cdot G_{cyd}(s) \cdot G_{yeq}(s)s} \quad (84)$$

However, the closed loop transference force function $G_{xf-cl}(s)$ is as follows.

$$G_{xf-cl}(s) = \frac{K_{ctrl} \cdot G_{xf-op}(s)}{1 + K_{ctrl} \cdot G_{xf-op}(s)} \quad (85)$$

Consequently, this is convenient to analyze system stability, dynamic characteristics, and other related indexes after using the equivalent treatment [16] [17] [18].

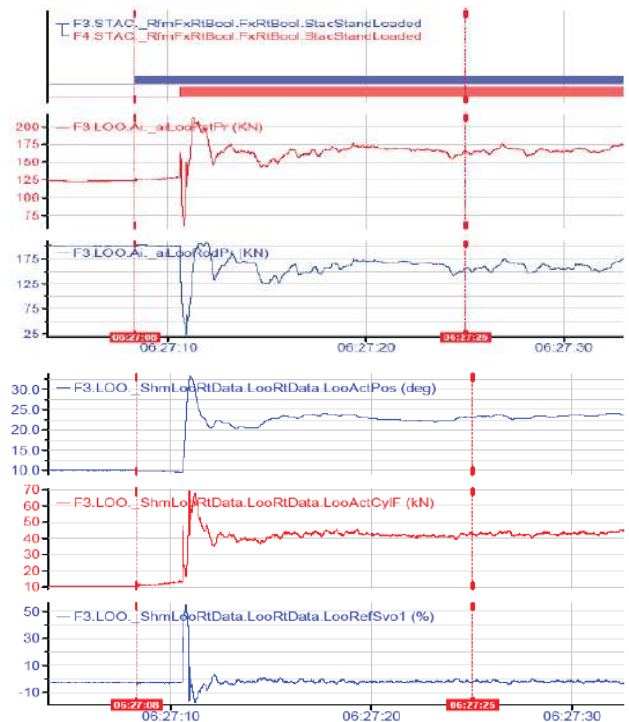


Fig.9: Practical response curve of the looper hydraulic unit closed loop control force

In hot strip finishing mill looper control systems, the closed loop force control is the main variable of the control system used in the looper hydraulic circuit.

According to looper angle changes, the output force of the hydraulic cylinder can be adjusted to maintain constant strip tension, and therefore the dynamic performance directly affects the looper response quality. Respecting the hydraulic cylinder structural data, the equivalent transference functions $G_{xeq}(s)$ e $G_{yeq}(s)$ are as follows.

$$G_{xeq}(s) = \frac{12.52 \times 10^4}{\left(\frac{s}{143.0} + 1 \right)} (N/\%) \quad (86)$$

$$G_{yeq}(s) = \frac{2.12 \times 10^4}{\left(\frac{s}{143.0} + 1 \right)} (mm/\%) \quad (87)$$

The equivalent transference function mentioned above considers the flow changes in different directions of servo valves.

The simulation was conducted according to the equivalent model, as per the curves are shown in Figure 10. Before 0.3 seconds, the looper closed-loop force control element is stationary, and the pressures on both cavities are 12.4 and 20.0 Mpa, respectively. In 0.3 seconds, due to the force, there is a leap of 30 kN on the force controller function, the looper hydraulic cylinder moves gradually to a new stationary state, and the pressures on both cylinder cavities change to 15.8 and 16.9 Mpa. The rise time is approximately 0.1 seconds, and the adjustment time is approximately 0.2 seconds[19] [20] [21].

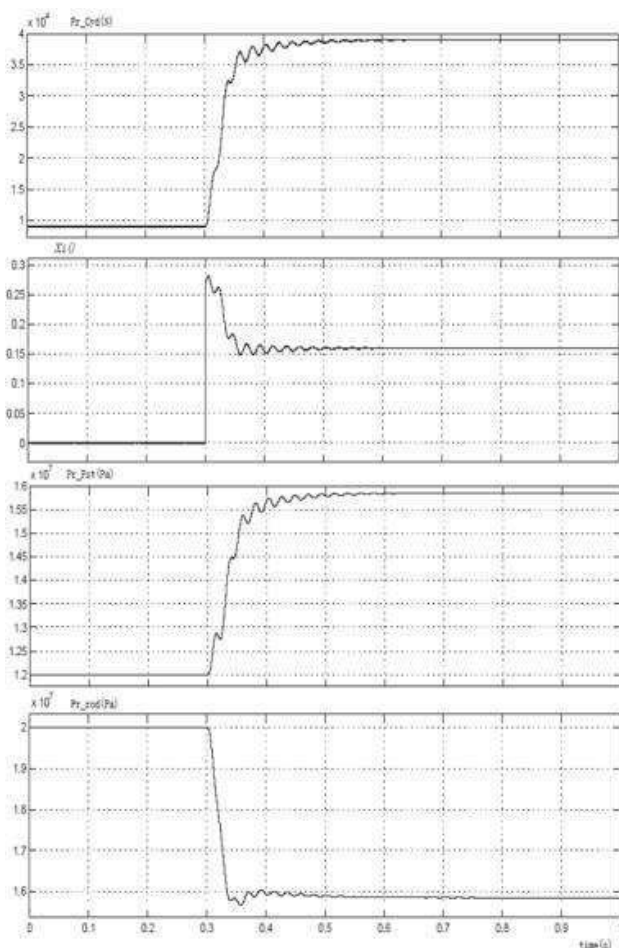


Fig.10: Response curve to closed loop force simulations in looper hydraulic units

IV. CONTROL MODES OF LOOPERS WITH HYDRAULIC CYLINDER CONTROLLED BY SERVO VALVES

4.1 ILQ control mode

ILQ control consists of strip tension and height control on the gap between the finishing mill roll stands. The strip tension and height are maintained according to the values defined by the controller, which changes the previous roll stand speed and the looper angle. The ILQ control has three (3) different control blocks that depend on the main motor and looper drive types, namely:

- a- DC (Direct Current) looper electric motor and roll stand motor;
- b- AC (Alternating Current) looper electric motor and roll stand motor;
- c- AC (Alternating Current) looper hydraulic cylinder and roll stand motor;

Figure 11 illustrates the control diagram block for AC (Alternating Current) hydraulic cylinder and main roll stand motors, object of the present study.

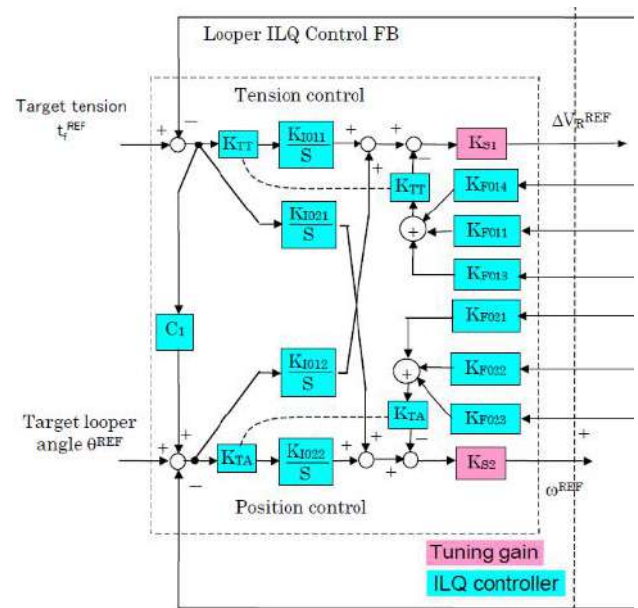


Fig.11: Control diagram block, using the position of the hydraulic cylinder in the looper and AC roll stand motor

4.2 PI control mode

The PI control is similar to the ILQ control, consisting of strip tension and height control on the gap between the finishing mill roll stands. In this mode, to maintain the defined strip tension and height values, the controller acts on the speed of the previous roll stand and looper torque.

The PI controller has the same control blocks as the ILQ controller.

Figure 12 illustrates the control diagram block for AC (Alternating Current) hydraulic cylinder and main roll stand motors, object of the present study.

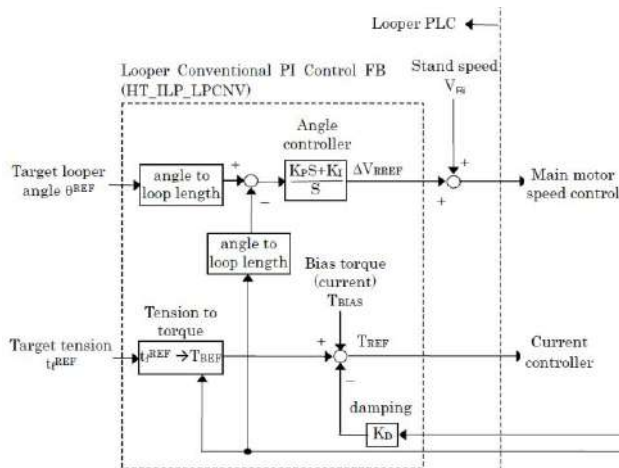


Fig.12: Control diagram block, using the torque of the hydraulic cylinder in the looper and AC roll stand motor

4.3 Predictive PI and ILQ controllers Development and parameterization of adaptive and predictive Proportional Integral (PI) e Integral Linear Quadratic (ILQ) controls.

The optimization work of both mill control modes does not require the installation of software or hardware. The control modes were optimized and improved in stages, which in the end allowed adjusting the control parameters of both control modes. The stages included:

- a- Collection of strip production data and variables controlled:
 - a- Product final thickness, obtained after the last roll stand of the finishing mill;
 - b- Product final width, obtained after the roughing mill;
 - c- Steel degree of resistance, which can be BR – Low Resistance, MR – Medium Resistance, and AR – High Resistance.
- b- Looper and drive system dynamic and static modeling;
- c- Analysis of the control system and operation modes;

- d- Production data analysis;
- e- New control mode parameterization based on stages a, b, c, and d.
- f- Analysis of results and parameter adjustments.

4.3.1 Production data collection

Hot Strip Mill N°2 in Cubatão produces nine (9) main types of steels:

- a- High Strength Low Alloy Steel (HSLA);
- b- High Carbon Steel;
- c- Medium Carbon Steel;
- e- Interstitial Free Steel – steel with low percentages of interstitial elements;
- f- American Petroleum Institute Steel – steel for the oil and gas industry;
- g- Dual Phase Steel;
- h- Transformation-Induced Plasticity Steel (TRIP);
- i- Grain Non-Oriented Steel (GNO) - steel for electrical purposes.

Each of these types of steel has specific chemical compositions, defined for level three (3) of the automation architecture of Hot Strip Mill No. 2 in Cubatão, by means of a table created from the range of each chemical element that composes these types of steel and their dimensions, either final product width or thickness. This information is essential to achieve correct mass flow control in the finishing mill, by selecting the two (2) looper control modes available for the operators, as described and presented in item 2 herein.

The main characteristics defined to collect process data are as follows:

- a- Steel families;
- b- Hot coil width;
- c- Hot coil thickness.

4.3.1.1 Steel families

There are four (4) main components considered to define the steel families, using the quantity of each chemical component per range:

- a- Basic and primary category of chemical components C, Mn, and Si;
- b- Category of micro-alloy steels with chemical components Nb, Mo, V, and Ti;

- c- Category of steels resistant to corrosion, with chemical component Cu;
- d- Category of boron steel, with chemical component B.

Figure 13 shows the flowchart used to identify steel family categories and Tables 4 and 5 show the range of each chemical component, according to the previous definitions of the quantity of each chemical component according to the type of steel to be milled and level three of the automation architecture:

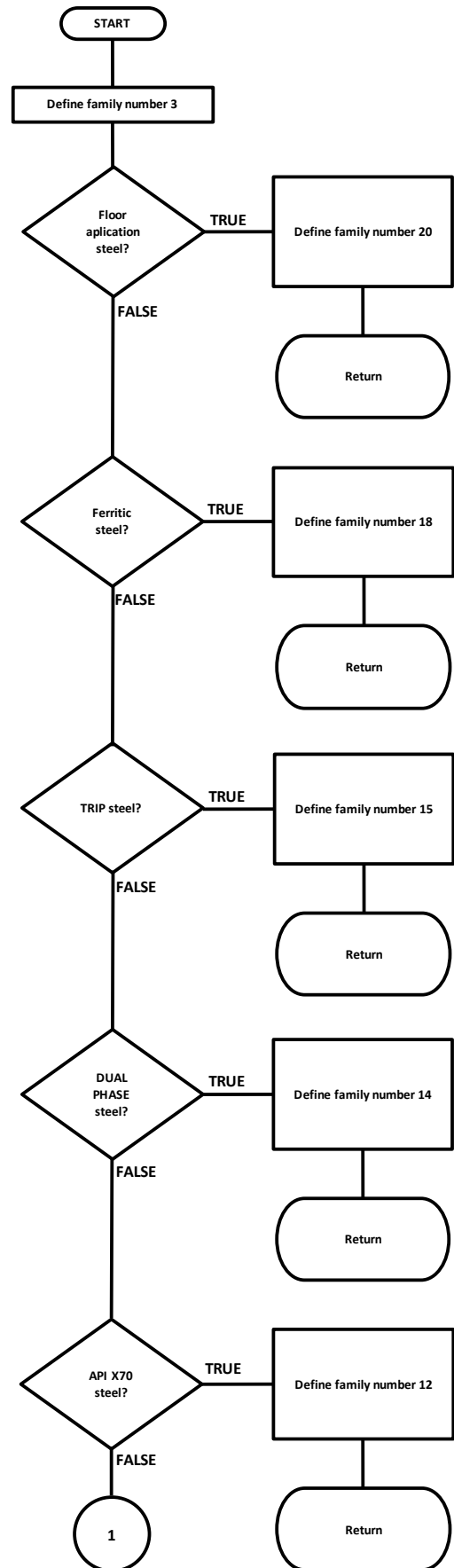


Fig.13: Steel family flow chart

Table 4 - Steel families and chemical composition ranges

Steel Family	Steel Description	Carbon Range	Alloy Range
1	Ultra Low Carbon	$C \leq 0.01$	-
2	Ultra Low Carbon and IF	$C < 0.01$	(Nb_1 ou Ti_1 ou Mo_1 ou V_1 ou B_1)
3	Low Carbon	$0.01 < C \leq 0.25$	-
4	Low Carbon and Corrosion Resistant	$0.01 < C \leq 0.25$	Cu_1
5	Low Carbon and Micro Alloy	$0.01 < C \leq 0.25$	(Nb_2 ou Ti_2 ou Mo_2 ou V_2)
6	Low Carbon and Boron Inclusion	$0.01 < C \leq 0.25$	B_2
7	Medium Carbon	$0.01 < C \leq 0.55$	-
8	Medium Carbon and Micro Alloy	$0.01 < C \leq 0.55$	(Nb_3 ou Ti_3 ou Mo_3 ou V_3)
9	Medium Carbon and Boron Inclusion	$0.01 < C \leq 0.55$	B_3
10	High Carbon	$0.55 \leq C$	-
11	Manganese	-	Mn_1
12	X59 and X70 Tubes	-	Value defined by the client on the sales order
13	Tubes above X80	-	Value defined by the client on the sales order
14	Dual Phase	-	Value defined by the client on the sales order
15	TRIP	-	Value defined by the client on the sales order
16	NGO	-	Si_1
17	RCO	-	Si_2
18	Ferritic	-	Value defined by the client on the sales order
19	X42 and X46 Tubes	-	Value defined by the client on the sales order
20	Floor Plates	-	-

Table 5 - Alloy component patterns

Chemical Element	Symbol	Threshold Value	Chemical Element	Symbol	Threshold Value
C	C_1	0.01	Mo	Mo_1	0.001
	C_2	0.25		Mo_2	0.001
	C_3	0.55		Mo_3	0.001
Si	Si_1	0.59	V	V_1	0.018
	Si_2	0.55		V_2	0.018
	Si_3	0.55		V_3	0.018
B	B_1	0.05	Mn	Mn_1	1.20
	B_2	0.05			
	B_3	0.05			
Cu	Cu_1	0.15			
Nb	Nb_1	0.008			
	Nb_2	0.008			
	Nb_3	0.008			
Ti	Ti_1	0.01			
	Ti_2	0.01			
	Ti_3	0.01			

4.3.1.2 Hot coil dimensions

Hot Strip Mill N°2 in Cubatão produces hot coils with the following final product width and thickness dimensions:

- a- Width: 750 to 2050 mm
- b- Thickness: 1.5 to 20 mm

These dimensions were divided into ranges: there are eight (8) width ranges and twenty (20) thickness ranges, all according to the dimensions of the final product. These dimensions and ranges are included in each of the twenty (20) steel families defined in item 4.3.1.1.

Table 6 shows the looper unit tensions for family 8 steels: medium micro-alloy carbon steel with 700 to 900 mm in width.

Table 7 shows the looper unit tensions for family 8 steels: medium micro-alloy carbon steel with 1350 to 1500 mm in width.

Table 6 – Looper unit tensions for family 8 steels with 700 to 900 mm width, per thickness range

Width Index (mm)		Thickness Index (mm)	Looper Unit Tension for each roll stand gap				
			(Mpa)				
			F1-F2	F2-F3	F3-F4	F4-F5	F5-F6
1	700 <= w < 900	1 1.2 <= h < 1.3	5.3	8.5	10.9	18.2	23.3
		2 1.3 <= h < 1.5	5.2	8.2	10.6	17.4	22.2
		3 1.5 <= h < 1.7	8.0	11.0	14.0	16.0	20.5
		4 1.7 <= h < 1.9	8.0	11.0	14.0	16.0	19.0
		5 1.9 <= h < 2.2	8.0	11.0	14.0	16.0	19.0
		6 2.2 <= h < 2.5	7.0	9.5	11.5	13.5	16.0
		7 2.5 <= h < 2.9	6.0	8.5	10.5	12.5	15.0
		8 2.9 <= h < 3.4	6.0	8.5	10.5	12.5	15.0
		9 3.4 <= h < 4.0	6.0	8.5	10.5	12.5	15.0
		10 4.0 <= h < 5.0	5.0	7.5	9.5	11.5	14.0
		11 5.0 <= h < 6.5	4.1	5.5	6.8	10.0	12.0
		12 6.5 <= h < 8.0	3.9	5.2	6.4	9.2	10.8
		13 8.0 <= h < 9.5	3.8	4.9	6.0	8.5	10.0
		14 9.5 <= h < 11.0	3.7	4.7	5.7	8.0	9.3
		15 11.0 <= h < 13.0	3.6	4.5	5.5	7.5	8.7
		16 13.0 <= h < 15.0	3.5	4.3	5.2	7.1	8.1
		17 15.0 <= h < 17.0	3.4	4.1	5.0	6.7	7.7
		18 17.0 <= h < 19.0	3.3	4.0	4.8	6.4	7.3
		19 19.0 <= h < 22.0	3.3	3.9	4.6	6.1	6.9
		20 22.0 <= h	3.2	3.7	4.5	5.8	6.6

Table 7 – Looper unit tensions for family 8 steels with 1350 to 1500 mm width, per thickness range

Width Index (mm)		Thickness Index (mm)	Looper Unit Tension for each roll stand gap (Mpa)					
			F1-F2	F2-F3	F3-F4	F4-F5	F5-F6	
4	1350 <= w < 1500	1	1.2 <= h < 1.3	5.4	8.7	11.5	18.4	23.5
		2	1.3 <= h < 1.5	5.3	8.4	11.1	17.6	22.3
		3	1.5 <= h < 1.7	10.0	13.0	16.0	18.0	22.5
		4	1.7 <= h < 1.9	10.0	13.0	16.0	18.0	21.0
		5	1.9 <= h < 2.2	10.0	13.0	16.0	18.0	21.0
		6	2.2 <= h < 2.5	9.6	12.1	14.5	16.5	19.5
		7	2.5 <= h < 2.9	9.6	12.1	14.5	16.5	19.5
		8	2.9 <= h < 3.4	9.6	12.1	14.5	16.5	19.5
		9	3.4 <= h < 4.0	9.6	12.1	14.5	16.5	19.5
		10	4.0 <= h < 5.0	8.6	11.1	13.5	15.5	18.5
		11	5.0 <= h < 6.5	6.2	7.7	10.2	13.2	15.1
		12	6.5 <= h < 8.0	4.0	5.3	6.7	9.3	10.9
		13	8.0 <= h < 9.5	3.9	5.0	6.3	8.6	10.1
		14	9.5 <= h < 11.0	3.8	4.8	6.0	8.1	9.4
		15	11.0 <= h < 13.0	3.7	4.6	5.7	7.6	8.8
		16	13.0 <= h < 15.0	3.6	4.4	5.4	7.2	8.2
		17	15.0 <= h < 17.0	3.5	4.3	5.2	6.8	7.7
		18	17.0 <= h < 19.0	3.4	4.1	5.0	6.5	7.4
		19	19.0 <= h < 22.0	3.3	4.0	4.8	6.2	6.9
		20	22.0 <= h	3.3	3.8	4.7	5.9	6.6

4.3.1.3 Looper unit tension

As described in item 1, there is a looper installed between each finishing mill roll stand. Due to the dimensions (width, and thickness), within each of the 230 steel families, there are unit tensions for each looper. These tensions are references used by the controllers to maintain the correct mass flow between each finishing mill roll stand, according to item 4. Figure 14 shows the unit tensions applied before implementing the study herein, and Figure 15 shows the unit tensions applied after the implementation:

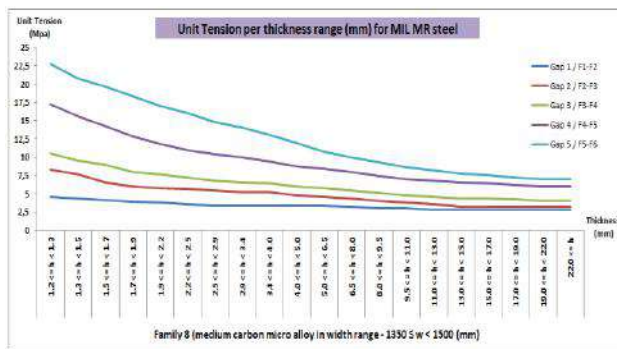


Fig.14: Unit tensions before implementation

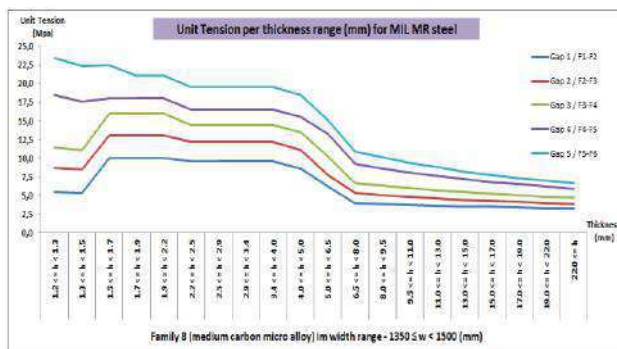


Fig.15: Unit tensions after implementation

4.3.2 Looper dynamic model and analysis of operational modes

These stages are described and presented in item 2 herein.

4.3.3 Production data analysis

After implementing the new unit tensions, using the reference variables defined in the previous items, to validate the operation mode appropriate for each of the steel families and dimensions. The appropriate looper control mode to be used by the production operators in the finishing mill is defined by two groups:

- a- For materials with a thickness of more than 6 mm and width of more than 1500 mm, in the Table 8 defines the operation modes for each looper in the finishing mill:

Table 8 – Looper operation modes defined for item a

Gap between roll stands	Operation Mode
1~2	ILQ
2~3	ILQ
3~4	ILQ
4~5	PI
5~6	PI

- b- For materials with a thickness of less than 6 mm and width of less than 1500 mm, in the Table 9 defines the operation modes for each looper in the finishing mill:

Table 9 – Looper operation modes defined for item b

Gap between roll stands	Operation Mode
1~2	ILQ
2~3	ILQ
3~4	ILQ
4~5	ILQ
5~6	ILQ

4.3.4 New parameterization of control modes

The models were followed -up over a period, with adjustments and adaptations to better represent looper control during the milling process.

Historical data was followed-up to allow interventions in order to avoid incidents during the milling process.

In the ILQ model, the interventions were made on the two main control variables, with changes in the loop gains:

- a- Tension control: Gain adjustment of variables K_{TT} and K_{S1} , for tensions between roll stands, reducing or increasing the speed of the previous stand to ensure the correct mass flow, as shown in Chapter 5, Item 5.1 and Figure 11.
- b- Position control: Gain adjustment of variables K_{TA} and K_{S2} , for looper angles, reducing or increasing the height to ensure

the correct mass flow, as shown in Chapter 5, Item 5.1 and Figure 11.

In the PI model, the interventions were made on the two main control variables, with changes in the loop gains:

- a- Tension control: Gain adjustment of the variable K_{PS} , for tensions between roll stands, reducing or increasing the speed of the previous stand to ensure the correct mass flow, as shown in Chapter 5, Item 5.2 and Figure 12.
- b- Torque control: Gain adjustment of the variable K_D , for looper torque, reducing or increasing the height to ensure the correct mass flow, as shown in Chapter 5, Item 5.2 and Figure 12.

4.3.5 Analysis of results

After the changes implemented in models ILQ and PI, we achieved improvements in the following process indicators of Hot Strip Mill N°2:

- a- Effective use: More than 82% for six consecutive months, unprecedented performance in the process, as shown in Figure 23;
- b- Finishing mill scrapping: In September 2017 and February 2018, with zero scrapping results, as shown in Figure 24;
- c- Drop or deviations: Less than 0.4% for six consecutive months, unprecedented performance, as shown in Figure 25;
- d- Rework: Less than 3% for five consecutive months, as shown in Figure 26;
- e- Processing costs: Average lower than US\$50/t in 2017; lowest value in November with US\$46/t, as shown in Figure 27;
- f- OTIF: Average over 2017 of 96.57%, unprecedented performance, as shown in Figure 28.

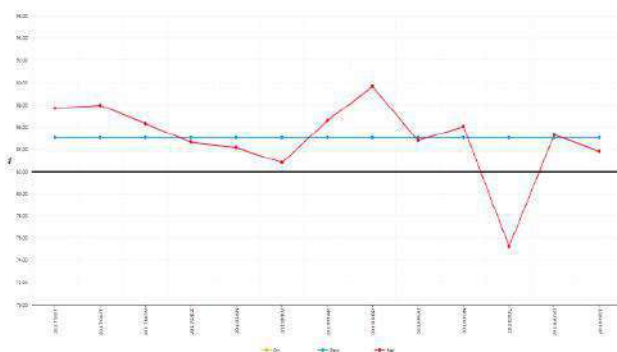


Fig.23: 2017 effective use performance in Hot Strip Mill N°2 – Cubatão – USIMINAS

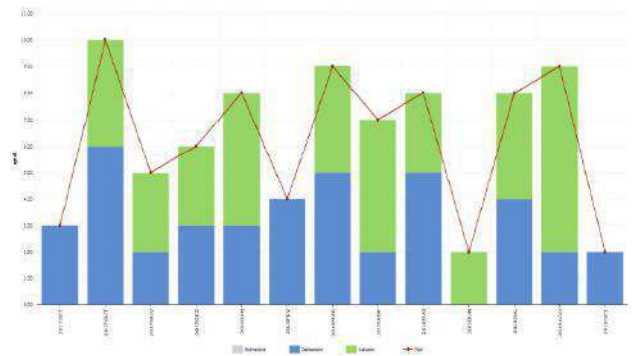


Fig.24: 2017 scrapping performance in Hot Strip Mill N°2 – Cubatão – USIMINAS

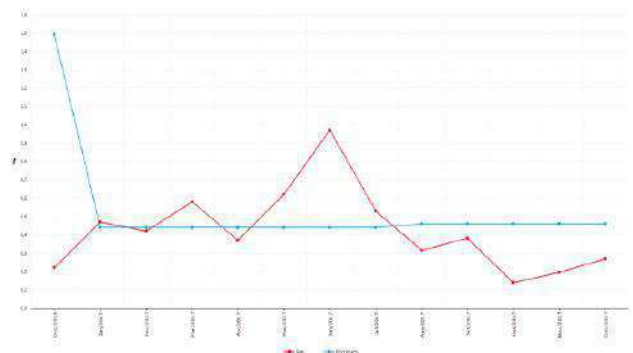


Fig.25: 2017 loss or deviation performance in Hot Strip Mill N°2 – Cubatão – USIMINAS

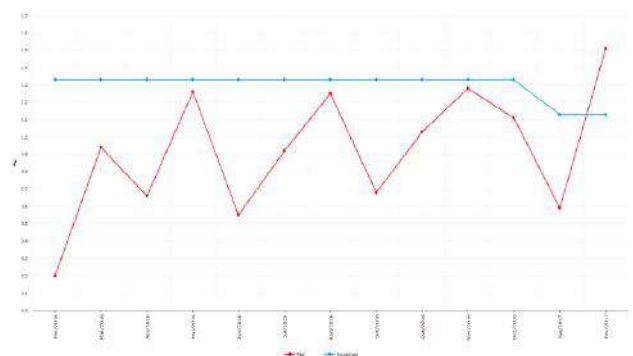


Fig.26: 2017 rework performance in Hot Strip Mill N°2 – Cubatão – USIMINAS



Fig.27: November 2017 processing cost performance in Hot Strip Mill N°2 – Cubatão – USIMINAS

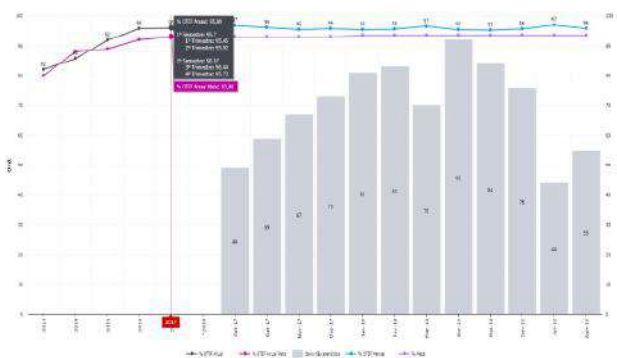


Fig.28: 2017 OTIF (On Time In Full) performance in Hot Strip Mill N°2 – Cubatão – USIMINAS

V. CONCLUSIONS

Currently, as described in the introduction herein, the production of hot strip coils in Hot Strip Mill No. 2 of USIMINAS– Usina Siderúrgica de Minas, in the city of Cubatão in Brazil, employs two control systems: PI and ILQ.

These systems operate satisfactorily, as described in item 2, but there are quality issues and impacts on production.

The main purpose of the present research work show herein is to create a procedure to allow production operators to take appropriate decisions regarding the type of controller to be used and the controller parameters to be employed.

This regulatory procedure shall significantly eliminate the quality issues described in item 2 herein; therefore, we developed the looper dynamic and static models to obtain the looper control modes described in item 4 above. The new regulatory procedure was implemented in continuous operation, and the production obtained was analyzed as presented in item 4.3.5 herein; six significant production and quality improvements were obtained.

Therefore, we can conclude that the development and application of the new regulatory procedure contributed significantly to improve global production.

To continue the survey, we suggest that the relationship between the PI or ILQ control modes and respective parameter adjustments shall be automated employing Artificial Intelligence techniques, in order to incorporate industry 4.0 parameters in the productive sector.

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Analysis of genetic divergence through agronomic characters in green corn cultivars

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Keywords— Genetic, Genotypes,
Multivariate analysis.

Abstract— The genetic divergence in maize populations is important, as it allows us to identify among the existing genotypes, the best ones to be used as parents in future breeding programs as a strategy for obtaining greater gains. Therefore, the objective of this work was to estimate the genetic divergences in green corn cultivars. The tests were conducted in the 2019/20 harvest on a property in the state of Pará. The design used in the given experiment was randomized blocks (DBC) and 3 replicates. The experimental plot consisted of 4 rows of 5.0 m spaced at 0.9 m between rows, the two central rows being considered the useful area. The genetic divergence was evaluated by multivariate procedures such as the generalized Mahalanobis distance and by Tocher optimization grouping methods and Singh criterion to quantify the relative contribution of the seven characteristics. The characteristics average mass of grains per ear and number of grains in the row of the ear were the ones that most contributed to genetic divergence. The dual hybrids BR205 and BRS3046 and the triple hybrid AG8088 are potentially promising for use in future breeding programs.

I. INTRODUCTION

In Brazil, the amount of total maize produced in 2020/2021 can come to 108,068 thousand tons of corn in the country, with emphasis on the volume predicted in the second harvest, which represents almost 77% of this total. With an increase in 5.4% in relation to the harvest 2019/20. The total planted area was stimulated in 19,495.2 thousand hectares, with a productivity of 5543 kg ha⁻¹ [1].

In Brazil, around 36 thousand hectares of sweet corn, and practically 100% production are intended for industrial processing for human consumption, with movement around R\$ 550 million a year, which is why it is also

called special corn. This follow-up has grown in recent years and the trend is the maintenance of this growth, aiming at the internal and foreign market. One of the factors that did not allow the consumption of sweet corn to be spread more rapidly among Brazilians was the lack of cultivars adapted to our environment conditions, in its almost full tropical [2].

The sweet corn harvest is carried out when the grains are still high in moisture (greater than 70%), which highlights the interference of the physiological stage of grain maturity in the yield. Therefore, the most propitious time for harvesting is the period in which the grains reach

the maximum point of dry matter accumulation and water content. This interval, known as the useful harvest period, varies between genotypes [3].

Due to the need for cultivars that present specific characteristics for the green corn market, private companies and public research institutions have intensified in breeding programs artificial selection schemes aimed at obtaining genotypes that meet the minimum requirements of the consumer market. In the selection, it should be taken into account the obtaining of genotypes with high yield potential, pericarp texture, adaptability and productive stability, which will allow its wide recommendation for cultivation [4]. However, even with the advance of genetic improvement, the availability of cultivars recommended for green corn production is scarce, and often farmers end up using specific genotypes for grain production or silage, which generates disinformation of the product, which end up not meeting the minimum requirements of the consumer market.

The study of genetic diversity through multivariate analysis is important for breeding programs, as the variability among genotypes is essential to obtain selection gains in crosses of genetically divergent groups that present characteristics of interest [5].

Genetic divergence has been studied in several cultures based on morphoagronomic, molecular and both characters, aiming at the selection of parents for the formation of hybrid combinations and/or formation of new segregating populations from crosses with more divergent genotypes [5].

The more divergent the parents, the greater the resulting variability in the segregating population, and the more likely it is to regroup allows into new favorable combinations [6]. Among the various dissimilarity measures proposed for the quantification of distances between genotypes, the generalized distance of Mahalanobis has been the most widely used when experimenting with repetitions [7]. This differs from other techniques by taking into account the correlations between the characters evaluated [5].

There are several studies of genetic divergence involving the culture of acai [8], cotton [9], carrot [10], broad bean [11], bean [12 and 13], passion fruit [14], melon [15], corn [16 and 17] and wheat [18]. Than has been guiding the bestists in the proper choice of parents.

With the advent of new technologies and studies, these techniques have become more common among specialist and corn crop improver [7, 8, 19, 20, 21, 22, 23, 24, 25 and 26].

Based on this model, the main objective of the study was to estimate genetic divergence through agronomic characters in 12 green corn cultivars in the crop 19/20 in the municipality of Santa Maria of Barreiras, State of Pará.

II. MATERIAL AND METHODS

The experiment was carried out at Sítio Vitória, located in the municipality of Santa Maria of Barreiras -PA, in sowing carried out on November 28, 2019, in the transition from the cerrado biome to the Amazon biome (Figure 1).

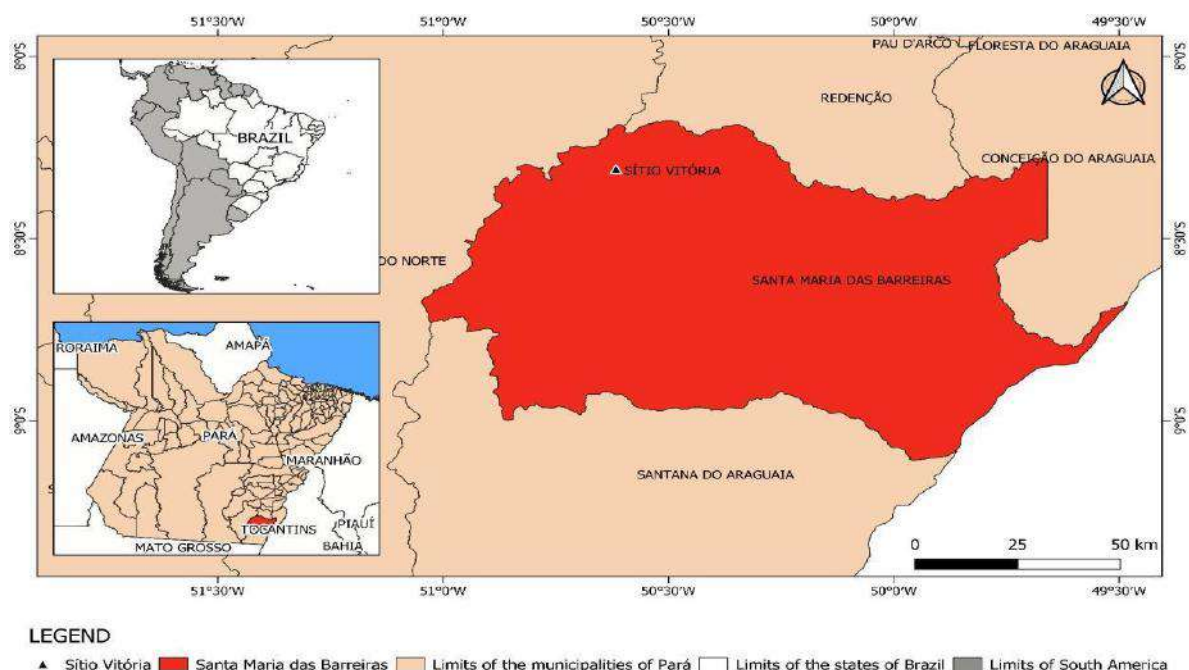


Fig.1. Location Map of Sítio Vitória, in the municipality of Santa Maria of Barreiras, State of Pará.

The region has a predominantly tropical climate according to Koppen the Aw, with rains in summer and with a distinctly dry season in winter, and the precipitation

and temperature data obtained over the conduction period of the experiment are shown in Figure 2.

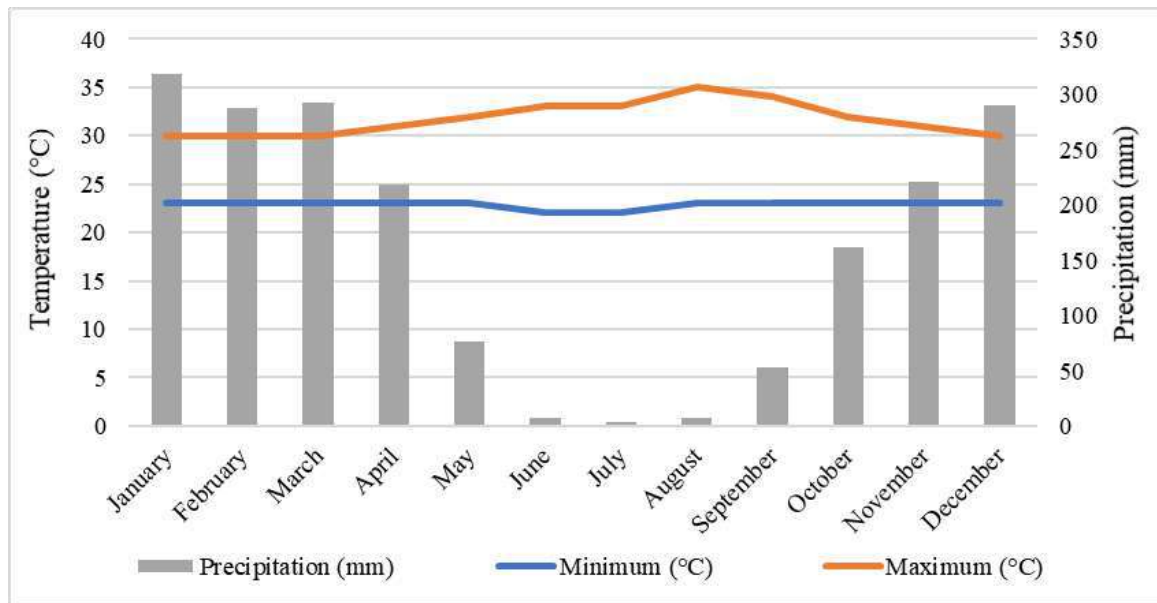


Fig. 2: Precipitation climatological averages, minimum temperature and maximum of the municipality of Santa Maria of Barreiras, Estado of the Pará in the year of 2019.

Fonte: Climatempo [20].

The results of the chemical analysis and soil texture are presented in Table 1.

Table 1. Chemical attributes and soil granulometry used in the first epoch of the experiment. Santa Maria of Barreiras-Pará, 2018.

pH	P meh	K	S	Ca ⁺²	Mg ⁺²	Al ⁺³	H+Al	M.O.	C.O.
CaCl ₂	mg.dm ⁻³				cmolc.dm ⁻³			dag.kg ⁻¹	%
4.8	4.9	43	3.0	1.7	0.3	0.20	3.10	1.7	1.0
SB	CTCt	V %			m	Clay	silt	sand full	
	mg.dm ⁻³						%		
2.11	5.21	40			9.0	15.0	5.0	80.0	

Font: Solocria [28].

The experimental design used was randomized blocks (DBC) with 12 treatments and three replications. The treatments consisted of maize cultivars, three pollination varieties, open, one single hybrid, seven double hybrids

and a triple hybrid, whose characteristics are found in Table 2. The experimental plot consisted of 4 rows spaced from 5.0 m in length per 0.9 m between rows, and the two central rows were considered as a useful area.

Table 2. Agronomic characteristics of corn cultivars used in the experiment.

Name	Base	Transgenics	Cycle	Finality	Level
AG 1051	HD	C	SMP	G/MV/SPI	M/A
AG 8088 PRO2	HS	PRO2	P	G/SPI	A
ALBANDEIRANTE	PPA	C	SMP	G/SPI	B/M

ANHEMBI	PPA	C	P	G/SPI	B/M
BM 3051	HD	C	P	MV/SPI	M/A
BR 2022	HD	C	P	G/SPI	M/A
BR 205	HD	C	P	G/SPI	M/A
BR 206	HD	C	P	G/SPI	M/A
BRS 3046	HT	C	SMP	MV	M/A
CATIVERDE	PPA	C	SMP	MV/SPI	M
M 274	HD	C	P	G/SPI	B/M
PR 27D28	HD	C	SP	G/SPI	B/M

HS: Simple hybrid; HD: Double hybrid; HT: Triple hybrid; PRO2: technology VT PRO 2™; C: conventional; P: precocious; SMP: Semi-early; SP: Superprecocoe; G: grain; MV: Green corn; SPI: Silage of whole plant; A: high; M: Medium B: low.

Soil tillage was performed in the conventional system, with a gradation followed by leveling the field. Pre-planting fertilization was calculated according to nutritional 1 levels obtained through soil analysis (Table 1), being applied manually using 300 kg ha⁻¹ of the formulated 5-25-15 (N-P₂O₅-K₂O) + 0,5% Zn. Where urea was used (45% from N) as the source of N, resulting in the full of 266 kg ha⁻¹, that have been fragmented into two applications, in the phenological V4 and V8, according to Ribeiro et al. [29].

The sowing was performed manually in the groove with an approximate depth of 0.04 m, immediately after seedling emergence, thinning was carried out to obtain the spacing of 0.02 m between plants, with the aim of obtaining a final population of 55,555 plants/ha.

Cultural treatments, such as phytosanitary control of diseases, pests and weeds were carried out according to the technical recommendations of the crop [30].

The harvest was carried out in the R3, in the two central rows, as it is when it is best suited for fresh consumption or processed [30].

The following characteristics were analyzed: plant height (AP) (cm), spike height (AE) (cm), ear weight with straw (PECP) (g), weight of the ear without straw (PESP) (g), spike length (CE) (mm), ear diameter (DE) (mm),

number of grains per row (NGE) and average grain mass per ear (MGE) (g). The descriptors were measured according to the Embrapa [2].

For the analysis of genetic divergence, measures of dissimilarities were used that were determined according to the multivariate analysis model, thus allowing the obtaining of dissimilarities, residual covariances and means of populations.

To establish similar groups, the grouping method was applied by optimization of Tocher [31], calculations of which were based on the generalised distance of Mahalanobis (D²) [32], and the criterion of Singh [33] to quantify the relative contribution of the seven traits evaluated in genetic divergence.

Statistical analyses were performed using the Computational Genes program, 2007 [34].

III. RESULTS AND DISCUSSION

Measures of genetic dissimilarity, estimated from the distance of Mahalanobis (Table 3), presented a high magnitude (9.72 to 70.70), indicating the presence of genetic variability among genotypes. Sodré et al. [26] found the magnitude of D² from 0.4 to 328.7 and Santos et al. [22] found magnitude (D² = 4.0 to 644.6) corn crop.

Table 3. Estimation of distances from Mahalanobis (D²) maximum and minimum number of maize genotypes.

Cultivate	Distance D ² among genotypes			
	Bigger	Cultivate	Minor	Cultivate
ANHEMBI	45.23	(BR205)	11.71	(BR2022)
BR2022	28.34	(BR205)	9.72	(BR206)

CATIVERDE	62.57	(BRS3046)	14.29	(BR205)
M274	43.57	(BR205)	10.27	(ALBANDEIRANTE)
AG 1051	69.78	(BR205)	11.74	(BM3051)
AG8088	51.39	(AG 1051)	13.17	(BR2022)
PR27D28	43.68	(BRS3046)	13.55	(BR206)
BR205	70.70	(BRS3046)	14.29	(CATIVERDE)
BRS3046	70.70	(BR205)	20.57	(BM3051)
BM3051	61.93	(BR205)	11.74	(AG 1051)
ALBANDEIRANTE	38.92	(BR205)	9.93	(BR2022)
BR206	28.00	(M274)	9.72	(BR2022)
Longer distance		70.70		(BR205 x BRS3046)
Shorter distance		9.72		(BR2022 x BR206)

In parentheses are represents cultivar(s).

The combination of cultivars BR205 x BRS3046 (Table 3) were considered the most divergent ($D^2 = 70.7$), followed by AG 1051 x BR205 ($D^2 = 69.78$). The shortest distances were between the combinations BR2022 x BR206, AL BANDEIRANTE x BR2022 and M274 x ALBANDEIRANTE ($D^2 = 9.72$; 9.93; 10.27 respectively). Combinations that result in longer distances represent genotypes that come from distinct germplasm banks, and shorter distances, materials that are probably from the same germplasm bank [22, 23, 25 and 35].

According to Santos et al. [7], the analysis of the genetic distance between cultivars leads to a faster, lower use of labor and financial resources that will be used in future programs to improve corn, because it allows the evaluation of distinct and promising materials to be inserted in breeding programs.

Table 4. Grouping by the Tocher method, based on the dissimilarity expressed by the generalized Mahalanobis distance.

Group	Access
I	BR2022, BR206, ANHEMBI, ALBANDEIRANTE, CATIVERDE and PR27D28
II	AG 1051, BM3051 and M274
III	AG8088 and BR205
IV	BRS3046

The first large group separated by the Tocher was composed of six cultivars (BR2022, BR206, ANHEMBI, ALBANDEIRANTE, CATIVERDE and PR27D28), the second by three (AG 1051, BM3051 and M274), the third group was formed by two cultivars (AG8088 and BR 205) and the room by the single cultivate (BRS3046).

To achieve, the desired maximum level of heterosis is necessary to make combinations between materials that are complementary, that is, in the locus where there are recessive alllinks in one material, in the other the allelo must be dominant and vice versa, thus generating the greater degree of heterosis [22].

Cluster analysis by Tocher method separates materials into distinct groups, so that there is intragroup homogeneity and intergroup heterogeneity [5]. After the dissimilarity measurements (D^2) were obtained, the cultivars were grouped into four groups (Table 4).

Groups formed by few genotypes indicate that they are divergent in relation to the others, facilitating the prospection of work in breeding programs [22, 23, 25 and 35].

The mean intergroup distances from the method of optimising Tocher (Table 5), indicate which groups are the most divergent. Thus, the least divergent groups were I

and II (23.96); and II and IV (27.17) (Table 5) and the most divergent were III and IV (56.43); and II and III (48.88).

Divergent groups can be used the basis for developing strains that will serve the future hybrid crosses, they require additional loci [16].

In this sense, the double hybrids BR205 and BRS3046 and the triple hybrid AG8088, because they are the most divergent (Table 3), are in distinct clusters (Table 4) and with the greater intergroup distance (Table 5), are potentially promising for use in future breeding programs in hybridization or self-fertilization processes for the extraction of strains.

Table 5. Average distances between groups formed by genetic divergence analysis in maize genotypes.

Group	II	III	IV
I	23.96	27.97	35.46
II		48.88	27.17
III			56.43

Regarding the contribution of the characteristics to the study of genetic divergence (Table 6), the one that most contributed was the MGE (25.59%), followed by the number of grains per row (NGF) (17.63%). The lowest contributions were of the characteristics PECP (5.66%)

and PESP (6.16%). The part, the characteristics of the PECP and PESP can be ruled out of future evaluations, as they contribute little to discriminating the materials evaluated, and can then reduce time, labor and costs in breeding programs [7, 22, 23, 24, 25 and 35].

Table 6. Relative contribution of traits in the genetic dissimilarity of genotypes.

Variable	Value in %
Plant height (AP)	12.96
Spike height (AE)	12.39
Ear weight with straw (PECP)	5.66
Ear weight without straw (PESP)	6.16
Number of grains per row (NGF)	17.63
Ear length (CE)	9.63
Ear diameter (DE)	9.98
Average grain mass per ear (MGE)	25.59

IV. CONCLUSION

The characteristics of average grain mass per ear and number of grains in the ear row were the ones that most contributed to genetic divergence.

Hybrids BR205 and BRS3046 and the hybrid BR205 and AG1051 are potentially promising for use in future breeding programs.

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Treatment of Legal-Criminal Error in Extreme and Limited Theories of Culpability

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Keywords— *Teoria da culpabilidade, erro jurídico penal, direito penal brasileiro.*

Abstract— *The limited theory of culpability, in terms of legal-criminal error, distinguishes between the error that falls on the technical assumptions of the one who recains on the existence or limits of the causes of exclusion of illegality (putative discrimination). The error that falls on the existence or limits of the justifying causes is a prohibition error and generates consequences similar to those treated in the extreme theory of culpability. However, when the error that falls on the phonic assumptions of the discrimination, they are considered a type error, it excludes the intent, but allows the punishment of guilt if the error was avoidable (absence of non-observance of the duty of care) and there is culpable prediction for the type. If there is exclusion of the intent, it is concluded that there is also exclusion from the typical fact and, consequently, from the antijuricity and guilt, in other words, there is no offense, in the hypothesis of invincible error. If there is no deceit (nor offense), the subject – the target of the error, will not be able to act in self-defense, having to bear the consequences of this fact, because if he reacts, he will have to answer for the delit.*

I. INTRODUCTION

This article brings to the knowledge, doctrinal discussion regarding the theories of culpability in the Brazilian criminal system, its reflections and considerations regarding legal-criminal error, thus bringing the distinctions of legal error, the technical assumptions and the existence and limits of the causes of exclusion of illegality.

It is brought with theoretical foundation of German origin, recommended by Welzel, its conceptualization, as can be invidenced in the chapters and finally, the conclusions and considerations on the theme presented here.

1.1 CONCEPT OF CULPABILITY AND ITS ELEMENTS

Welzel, conceptualizes culpability as the distaste of the individual antilegal fact, and the object of this distaste is the resolution of the anti-legal will in relation to the individual fact¹. Thus, the subject will only be attributable when, even though he/she can structure his will according to the norm, he does not, that is, the agent who can act otherwise did not act.

It is important to observe that, in the formation of the deed, two elements compete: one of intellectual, cognitive (prediction) and the other, of a volitional nature (where self-determination is located), remembering that these elements, although located in the conduct, are only valued in guilt. If, for some reason, one of these elements that

direct human action is working poorly at the time of conduct, in such a way that it alters the so-called freedom of will, removing from the individual the power and the power to act differently from how he acted, criminal imputability is removed.

As Bitencourt states, the author must know the unjust, or at least have the power to know him and must be able to decide for a conduct in accordance with the law by virtue of this knowledge (real or possible)². Welzel³ himself already described that the ability to accept guilt has two specific elements: one intellectual (cognoscivo) and another volition or will, which correspond to the ability to understand the unjust and the determination of the will according to that understanding.

Thus only the presence of the two elements together constitute the capacity for culpability, that is, the criminal imputability, which according to that author constitutes the essence of culpability.

The second important element, in the constitution of culpability, is the possibility of knowing the antijuricity of conduct, that is, the awareness of illegality, so that to the knowledge of the type it is necessary to add the knowledge of antijuricity. This knowledge of illegality, in psychological and psychological-normative theory, was in the *delo* (*dolus malus* – because it held the consciousness of illegality).

With the advent of pure normative theory of culpability, Welzel removed the deceit from culpability and placed it in the kind, and now as a natural deceit, without any animic-psychological element, making guilt pure normativity. As Tavares, quoting Welzel, says, "culpability is no longer integrated by the deed, but by an autonomous normative element: the potential awareness of illegality." This means that, for someone to be found guilty, it is necessary, in addition to being able to act on another (be attributable), to have knowledge or possibility of knowledge of the prohibition of the fact that it practices.

If for some reason, the subject does not have knowledge (not even potential) that he practices an anti-legal action (prohibited), he cannot be guilty. In imputability, one wonders whether the subject could act otherwise. In the potential awareness of illegality, the subject was questioned by knowledge or possibility of knowledge of the prohibition.

According to the finalist thought, once present the imputability (the power to act otherwise) and the possibility of knowledge of the prohibition, the materiality of culpability would be configured. However, in certain exceptional and concrete situations, even though the subject is attributable and knowing the anti-juridity of his conduct, even so, no reproof can be attributed to him.

This is the hypothesis of non-enforceability of different conduct, because in this case, the subject cannot structure his will according to a legal norm and, therefore, the legal-criminal order must renounce the distaste and exculpe the subject. This argument is very specific to the German legal theory which differentiates causes of exclusion of guilt from exculping causes, in which the punitive system renounces the distaste of the agent, if present concrete circumstances that demonstrate the impossibility of obedience to the law.

II. TYPE ERROR AND PROHIBITION ERROR

These elements of culpability have reached, as well as their applicability, reasonable pacificity, both in extreme theory and in the limited theory of culpability when used in relation to incriminating criminal norms. However, when it comes to justifying criminal norms, there are profound divergences in the two theories, in relation to these elements, especially with regard to the potential awareness of the anti-juridity, when, in the specific case, there is a legal-criminal error.

For the extreme theory of culpability every error that falls on causes of exclusion of illegality, it is a prohibition error, excluding culpability, due to the absence of the possibility of knowledge of antijuricity, in the specific case. When inevitable the error completely excludes, how avoidable, decreases the culpability (reduction of penalty).

The extreme theory makes no distinction between the error that falls on the phonic assumptions of the one that falls on the existence or limits of the justifying causes. In both cases, it is inevitable or avoidable error, the intent remains intact, because even in a situation of invincible error what is excluded is an element of culpability (the potential awareness of antijuricity).

Remaining the will intact, it is possible for the individual - the target of the error, to act in self-defense, because the deceit persists and, objectively, the antijuricity itself; The subject who acted for cognitive addiction (error) could answer by attempt, since he acted with deceit. Likely the participant (without error of cognition or conscience) could answer for the crime, because he acted in a demeanor.

The limited theory of culpability, in terms of legal-criminal error, distinguishes between the error that falls on the technical assumptions of the one who recedes on the existence or limits of the causes of exclusion of illegality (putative discrimination). The error that falls on the existence or limits of the justifying causes is a prohibition error and generates consequences similar to those dealt with in the extreme theory of culpability.

However, when the error that falls on the phonic assumptions of the discrimination, they are considered type error, excludes the intent, but allows the punishment of guilt if the error was avoidable (absence of non-observance of the duty of care) and there is culpable prediction for the type.

Se há exclusão do dolo, conclui-se que há também exclusão do fato típico e, por conseguinte, da antijuricidade e da culpabilidade, em outras palavras, não há delito, na hipótese de erro invencível. Ora se não há dolo (nem delito), o sujeito – alvo do erro, não poderá agir em legítima defesa, tendo que suportar as consequências desse fato, porque se reagir, terá que responder pelo delito.

Likewise, the subject who acted in error (inevitable or even avoidable) will not be able to answer by attempt, since in his action there is no deceit, having to go unpunished. Likely, the participant cannot be punished, on the basis of the principle of limited access that requires the action of the lead author to be typical and anti-legal.

III. CONCLUSION

Comparing the stun theories (of culpability) with the limited theory (of culpability) it is noticeable that the latter can lead, in the concrete case, to situations of injustice and impunity. However, it should be noted that the legal theory is dynamic and, therefore, is dialectically in a constant process of evolution and improvement, which will certainly cause the overcoming of these imperfections in the future.

Our Penal Code, which adopted the limited theory, deals with the prohibition error in Article 21, second part:

... The error about the illegality of the fact, if inevitable, exempt from penalty; if preventable, it may decrease it by one sixth to one third.

As can be seen in the first part, this is an inevitable error, it completely excludes culpability due to the absence of the possibility of knowledge of anti-juridity and, in the second part, deals with avoidable error, which reduces culpability, constituting a mandatory cause of reduction of sentence.

Therefore, Article 21 (prohibition error) regulates both the error that falls on the potential awareness of illegality (in the case of incriminating criminal norms), as well as, it regulates errors that fall on the existence or limits of the causes of exclusion of illegality (in this case permissive criminal norms).

Regarding type error, our Code disciplined in Article 20, Caput (the error that falls on the elements of the typical

incriminating fact – incriminating criminal rule) as follows:

The error about constitutive element of the legal type of crime excludes the deed, but allows the punishment for a guilty crime, if provided by law.

So, if the error was inevitable, it excludes the deed and, in turn, the typical fact that, consequently, the antijuricity and guilt. However, if the wrong person acted with no observance of the duty of care, then he may be punished for the wrongful crime, if there is a legal provision.

In Article 20, § 1, he disciplined (the error that falls on the phonic assumptions of the causes of exclusion of anti-juridical (putative discrimination) as follows:

Art. 20 -

§ 1 - It is exempt from penalty who, by error fully justified by the circumstances, assumes a de facto situation that, if it existed, would make the action legitimate. There is no penalty exemption when the error stems from guilt and the fact is punishable as a guilty crime.

Let's look at the example of putative self-defense:

Abel threatens to kill his brother Cain. One night, when they meet, Abel takes his hand to his suit pocket. Cain assumed he would draw a gun, shot first and killed Abel, checking after Abel did not hold a gun, but would pick up a handkerchief from his pocket.

Cain incurs an inevitable error about the political assumptions of a justifying cause (so-called putative discrimination).

In the present case, it excludes the deed and the fault, because the error is fully justified by the circumstances which, if it existed, would make the action legitimate. There's no punishment. Shady permissive type error.

However, it is important to highlight that if the error fell on the existing one or the limits of an exclusion of anti-revility, it would be an error of prohibition with the consequences that we narrated earlier.

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The Pyramid of Information - criticism and opportunity

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Keywords— DIKW, Data, Knowledge,
Representation.

Abstract— The Information Pyramid has been used in technical and academic texts for a long time. Its origin is still uncertain, and it is likely to remain so, but the structure established by Russell Ackoff in 1989 has been the basis for most of the representations found in articles and books. This pyramid has been the subject of criticism from several authors in different research fields. In this theoretical essay, some of the pyramid's development trails are retrieved. Different expressions of the pyramid are discussed, comparing and contrasting its elements, assumptions and implications, in search of a more comprehensive understanding of these elements and their intertwining. To make the exposure more fluid, the reviews were grouped into categories; these, however, should not be taken in isolation, since the focus of attention is the representation, its premises and its implications. It is concluded that the hierarchical representations of the relationships between data, information, knowledge and others are unable to adequately represent, even in a simplified way, the complex processes it intends to subsume. However, it is considered that this representation can still be an instrument of learning, since used critically, supporting discussions about the complexity and circularity of the phenomena that this representation expresses.

I. INTRODUCTION

Robinson and Bawden (2014) claim that information is a notoriously slippery and multifaceted concept, which has had many different meanings over the years and is used with different connotations in various domains. For them, almost every scientific discipline employs a concept of information within their particular context, to deal with phenomena that are specific to them. In the field of information sciences, where there have been debates about the concepts of data, the differences and the relationship between this concepts, this is a constant concern. Still according to Robinson and Bawden (2014), these debates led to two main classes of models. The first, based on Popper's objective epistemology, uses the expression 'knowledge' to denote what Popper called "World 2", the universe of psychic and mental experiences, the subjective knowledge in a person's mind. The expression 'information' denotes the knowledge communicated,

registered or directly exchanged between people, Popper's 'World 3' - that of critical problems, theories and arguments - necessarily codified in a document or physical communication of 'World 1', which is the set of concrete, organic and inorganic experiences. For Popper, information is knowledge in transit (Robinson & Bawden, 2014; Neiva, 1998) The second class of models treats information and knowledge as being of the same type of entity, knowledge being 'refined information', established within some broader structure. In this class of models, these concepts are usually represented in a linear progression or in a pyramid, starting with data and eventually culminating in 'wisdom'. Pyramids of information have been widely used in books and academic papers and many professionals in the fields of science and information technologies are 'literate' having this instrument as support. The question is: is the information pyramid an appropriate instrument for the formation of these professionals?

II. REVISITING THE PYRAMID OF INFORMATION

The Information Pyramid is a common figure in texts of Information Management and Knowledge Management. It is called by several names: Pyramid of Information, Pyramid of Knowledge, Pyramid of Wisdom and, less commonly, Hierarchy of Information or Hierarchy of Knowledge. It should not be surprising to realize that researchers of Science or Information Management, including the ones in Information Systems, opt for 'Information', while those from Knowledge Management opt for 'Knowledge' (Rowley, 2007). The variety of interpretations seems to match the amount of presentations. The concepts associated with each layer of the pyramid are usually presented and commented, and it is easy to identify different considerations by different authors. Nevertheless, few authors advance in discussing the processes underlying each layer, or in the processes that lead from one to the next. It is not questioned whether it is a pyramid. This shape seems attractive to management models, appearing in the Maslow Needs Hierarchy, in the representations of the hierarchy of information systems, in the representation of the hierarchical levels of an organization or in the conceptual representation of the dimensions Governance and Management in the Cobit 2019 model, for example. This form is also very common in sacred texts and esoteric literature, in which it is associated with the figure of the Creator and, by association, with knowledge and wisdom, forming the figure of the Eye of Providence. According to Berbert (2019), the use of the triangle contains a range of symbolisms, starting with religious aspects, as seen in triangular perfection that, according to Plutarch, led Plato to say that god geometrizes, but also in the Holy Trinity of Christianity or Hamsá of Islamic belief.

III. THE ORIGIN OF THE PYRAMID OF INFORMATION

Despite its popularity, the origin of the Information Pyramid is not clearly established (Wallace, 2007). Several authors attribute its creation – or at least its popularization – to Russel Ackoff, in an article published in 1989 (Hey, 2004; Bellinger et al, 2003; Rowley, 2007; Sharma, 2008; Weinberg, 2010; Schumaker, 2011; Robertson, 2013; Ronquillo et al, 2016). Wallace (2007) mentions Boulding as having proposed a hierarchy composed of signals, messages, information and knowledge as early as 1955, recognizing, however, that Nicholas L. Henry made the first reference to this hierarchy associated to knowledge management in a 1974 article. Sharma (2008), in turn,

identified origins in independent works by Milan Zeleny and Michael Cooley, both published in 1987. These two authors constructed hierarchical representations linking data to knowledge. Zeleny (1987) builds his proposal by associating data, information, knowledge and wisdom with successive stages of learning ("know nothing", "know what", "know how" and "know why", respectively). Cooley (1987) does so by discussing tacit and explicit knowledge. Schumaker (2011) recovers the Lectures of Frances Wright, american social reformer who proposes that objective knowledge should be constructed from the verification and investigation of facts, as opposed to the uncritical acceptance of the opinion of the majority or common sense, even when regarding to religion and morality (Wright, 1829).

However, the oldest reference to the pyramid of knowledge, in a text dedicated to the discussion of information, is by Harlan Cleveland, in an article published in 1982. In this article – which is not the case with the previous ones – Cleveland (1982) presents a source of inspiration: the poem "The Rock", published in 1934 by the English poet T.S. Elliot, which contains these three verses:

Where is the Life we have lost in living?

Where is the wisdom we have lost in knowledge?

Where is the knowledge we have lost in information?

(Elliot, 1934, pp.1)

It is common for only these three verses to be presented, decontextualizing them. Note that Elliot does not mention Data. Nor has Cleveland cast Data as an element in its hierarchy, which has only Information, Knowledge, and Wisdom. Elliot, for his part, associated knowledge with endless cycles of ideas and action. It's a deeply religious text that Kennedy (1973) explains considering that, for Elliot, the Word (the Logos, Christ, the Second Person of the Trinity) is an "untalking baby" whose exact meaning had become wadding or adulterated in darkness.

If Sharma's work shed some light on the origin of the Pyramid of Knowledge, other origins may be considered. For example, Ronquillo et al. (2016), dealing with informatics for nursing, mention that this area of knowledge was established by Graves and Corcoran in a 1989 article, in which they define it as

a combination of computer science, information science and nursing science designed to assist in the management and processing of nursing data, information and knowledge to support nursing practice and nursing care (Gaves and Corcoran,

1989 apud Ronquillo, Currie, & Rodney, 2016, p. 2).

These authors incorporate in their definition the data-information-knowledge structure established by Blum in 1986. Table 1 shows Blum's definitions.

Table 1 – Data, Information and Knowledge

Element	Definition
Data	Uninterpreted elements that are provided to the problem solver. For example: the name of a patient, a test result, or a diagnosis. Most mathematical calculations operate only with data. Using a formula to calculate the body surface from the patient's height and weight is a simple example of an application that operates only with data.
Information	A collection of data that contains meaning. Data processing usually ends with a view of information. The data (and information) must be stored in a permanent and accessible database. Example: online patient medical records that includes name, laboratory results, and diagnosis.
Knowledge	It is the formalization of the relationships between information elements and data. The formulation can be descriptive (e.g. a textbook) or it can be processed by computer. In the second case, knowledge can be expressed as a formula (as in the case of the body surface problem) or as a set of rules. The use of knowledge usually suggests the ability to infer data or information from those already present.

Source: adapted from Blum (1986, p. 35)

Also on this trail it is not clear the origin of the data-information-knowledge model, but the addition of Wisdom, proposed by Nelson and Joos (1989), defines a pyramid that is consolidated in the field of informatics for nursing. For Nelson and Joss (1989) wisdom is knowing how to use knowledge in to manage a patient need or problem (Nelson & Joss, 1989).

Despite his predecessors, it is common to attribute to Russell Ackoff, if not the initial proposition of the pyramid, at least the merit of having highlighted it. His inaugural address as president of the International Society for General Systems Research (ISGSR) in 1988, later published as an article in the Journal of Applied Systems (Ackoff, 1989), is the origin usually cited in articles and

books (Rowley, 2007). Less known, or less cited, is the fact that the aforementioned speech was written for an audience of engineers, having as its theme the distinction between what can be executed by computers and what can only be delt by humans.

The hierarchy originally proposed by Ackoff - but not represented in pyramid format - is Data-Information-Knowledge-Understanding-Wisdom. Data is defined as symbols that represent the properties of objects, events, and their environment. They are the result of observations, but they are not useful if they are not in the proper format; only after organized they become relevant. Relevance, therefore, is given by the organization of the data. Information is contained in descriptions, answers to questions about what is observed, in the pattern xWyH (what, who, when, where, how, how long, how many, how far ...). Knowledge is know-how: it is the possibility of transforming information into instructions, defining procedures. Knowledge answers questions such as 'how to', and allows control. Wisdom, in turn, is the ability to increase effectiveness. Between Knowledge and Wisdom there is Understanding, which allows to increase the efficiency of knowledge in terms of its construction as procedures. Intelligence optimizes the use and questions the applicability of Knowledge; it allows diagnosis and prescription, but does not alter knowledge. Wisdom requires capacity for judgment, which involves ethical and aesthetic values. According to Ackoff (1989), Information ages fast, Knowledge lasts a little longer, Understanding has an aura of permanence, vague and ethereal, but no more than an aura; only Wisdom can remain. The temporality of the Data is not questioned. It is possible to consider that Data only exists, in accordance with the etymology of the word; it may be possible to consider that data can be more permanent than Wisdom because if knowledge changes, then data can be revisited and reinterpreted without losing its condition of Data. Ackoff doesn't take care of it. Ackoff's definitions may be relatively adequate representations from the perspective of information systems, and it is not correct to expect from his conceptualizations more than he proposed to offer. It would not be correct to attribute to Ackoff the responsibility for the many "translations" that his proposal received or to affirm that these fully represent the thought of this author.

Information systems - even non-computer-based ones - organize data, making it accessible to those who need it. Knowledge allows to use this data in specific tasks, which, being logical can be programmed and automated. Thus, computers use data, which is processed by algorithms that embody a knowledge of how to process this data for a specific purposes. For them to be processable, relevant,

data needs to be properly structured, organized. Nicklaus Wirth, creator of the Pascal programming language, summed up this idea in the title of one of his most influential books: *Algorithms + Data Structures = Programs* (Wirth, 1976). The difference between Data and Information is functional; in a somewhat simplistic way, it can be said that Data is what is used as input for computational processes, and Information is the output. Intelligence is the ability to build other and better algorithms. It is an algorithmic view of knowledge production. Only wisdom escapes the attraction of information systems, because it is something that may exist only in the human, and so expressing leaves, if not clear, at least strongly indicated that what he had previously placed referred to the computable by automats.

Wisdom-generating systems are those that man will never be able to attribute to automats. It may well be that wisdom, which is essential for the effective search for ideals, and the very search for ideals, are the characteristics that differentiate man from machines (Ackoff, 1989, p.9)

For Ackoff (1989), Wisdom is the pursuit of ideals. Somewhat similar idea appears in the last layer of Zeleny's proposal (1986). If knowledge is "knowing why", Enlightenment is achieving a sense of truth, of what is right and what is wrong. However, if for Ackoff (1989) Wisdom is individual, for Zeleny (1986) it is socially built – the sense of truth, right and wrong, is what was socially accepted, respected and sanctioned. Ackoff (1989) does not question the correction of the data, how much "truth" they express. In addition, ethical and moral issues do not apply to them. From the perspective expressed by Ackoff (1989), discussions on ethical and moral aspects "add up" only at the level of Wisdom. The current debate on ethics and the 'Data Era', in its various expressions (social networks, big data, scientific research, artificial intelligence algorithms, ...) shows that, on the contrary, all activities related to data and information must deal with ethical considerations (Richterich, 2018; O'Keefe & O'Brien, 2018). O'Keefe and O'Brien (2018) affirm that, even when computer science and business management curricula have modules about ethics, these courses often do not provide the tools necessary for information management professionals to work according to and to apply robust ethical concepts in the execution of their daily roles. This leads to the "law of unintended consequences" (O'Keefe & O'Brien, 2018, p. 20), with technologies or analysis being deployed in the real world without an adequate analysis of the ethical implications or impacts.

There are, then, ontological and epistemological differences between the positions of Ackoff (1989) and

Zeleny (1987). It is noteworthy to note that Cleveland (1982), Zeleny (1986) and Ackoff (1989) defy what Elliot wrote, suggesting "gains" where Elliot (1934), perhaps foreseeing a world in which data is flooding (Ornes, 2013), attention runs out (Simon, 1997), information generates anxiety (Wurman, 2001), tensions (Choo, 2006) or overload (Sutcliffe & Weick, 2008), or are irrelevant (Gaeth & Shanteay, 2000), saw losses. Elliot's poem makes to think, literally questioning. The pyramid states several things without effectively stating any, but inducing a way of thinking. This induced way of thinking – more directly, think about the definition and relationship between data, information, knowledge, intelligence, wisdom; and indirectly, the individual relationship and society; the context of interaction; explicit knowledge and tacit knowledge; values and ideals - has been the subject of relevant criticism made by researchers from different areas. Razzolini Filho (2020, p. 170), for example, to emphasize the inversion of information structures at the beginning of the 21st century, with the emphasis on information technologies in the use of data, which stand out from other structures, flips the pyramid. Particularly striking are the criticisms related to the definition of a linear, hierarchical model of knowledge construction and the epistemological narrowness in which it is sustained. Difficulties in operationalizing the model have also produced important criticism.

IV. CRITICISM

In the next sections, some criticisms of the information pyramid are presented and commented on. The reviews were grouped into categories; these, however, should not be taken in isolation, since the focus of attention is the representation, its premises and its implications.

Linearization, Hierarchies and Value Judgments

In the Pyramid of Information, Data is understood as the most abundant element. They are the fundamental level on which the other concepts are based. The decreasing widths of the upper levels suggest lower abundance, lower amount, while the upward movement suggests an increase in "power" to support appropriate action. It is up to the reader's imagination to identify an appropriate unit to "measure" the "quantities" and "powers" of data, information, knowledge, intelligence and wisdom. Take, for example, a list of data regarding the age and height of students of a particular class. Statistical analyses and derived reports may take up much more disk space than the original data.

Thus, even with regard to infrastructure information systems this characterization needs to be revisited. Jennex and Bartczak (2013, p.22) proposed an inverted pyramidal

representation, keeping data at the base and wisdom at the top, because, considering that information is a combination of data, the several possible combinations generate much more information than data; according to them, the same goes for the other layers, in which elements as ethics, culture and religion generate different interpretations. But this pyramidal representation serves more to the purpose of assigning value to concepts in the model, characterized by dominance or importance, proposing a consolidation of power in the higher levels in relation to the lower levels – information "worth more than" data, wisdom "worth more than" knowledge.

Poore and Chrisman (2006) describe the problematic nature of this hierarchical representation, stating that "the pyramid of information incorporates and normalizes theories of power, reflecting the hierarchical social structures of the old industrial economy" (Poore & Chrisman, 2006, p. 511) and suggesting that the value of concepts in the Information Pyramid has the potential to overflow and be seen as applicable to individuals and professions, "with manual workers at the base and knowledge workers and bosses at the top" (Poore & Chrisman, 2006, p.511). Stating that literature rests on two metaphors - that of invariance, derived from Shannon's works, and that of the hierarchy of refinement, originated in the 19th century's utopian movements - consider that both prevent the important social and ethical issues involved.

Desrosières (1998) suggests that these representations derive from the taxonomic ideas of nature of the seventeenth century, which later led to the classification of populations for the construction and stabilization of the social order, the constitution of a common language that allows the coordination of individual acts so that systems are able to guide and trigger actions. Although authors such as Choo (2006) or Beal (2006) present non-pyramidal representations, their conceptions are also hierarchical, with unidirectional flows. As aforementioned the similarities of forms creates mechanisms of reinforcement and reciprocal legitimation, and induces belief in causal links, naturalizing a construct and legitimizing social structures. This leads to another possible criticism of such representations.

Teleology

The pyramidal representation explains the movement towards wisdom as the ultimate goal, to which the lower levels are subordinated. There is something teleological about this. For a moment, we return to Plato. In Plato, dialectics is a dialogue that gradually elevates the soul beyond the sensitive world, allowing discovering the essences that are beyond the transience of the world.

Platonic dialectics is the method that allows to lay down the practical life in the idea of Good — the *Summum Bonum*, the final destiny of all things, which Medieval Philosophy will associate with God. The constitution of the ethical subject implies the understanding of this *Summum Bonum*, and inspired by the strength of this Good, one can manage to overcome the excesses that threaten existence that is governed by balance and harmony. In Plato's ethics, The Beautiful and the Good articulate themselves - a form is beautiful if it constitutes in itself a perfectly harmonious whole. The Beautiful is the manifest form of the Good. In a world in which fake news and post-truth exert important – and harmful – influence, we can recover Protagoras of Abdera, who, denying the possibility of a universal criterion that allows man to know the truth and separate it from what is false, states that "of all things the measure is Man, of the things that are, that they are, and of the things that are not, that they are not". Protagoras also stated that "everything can be true, depending only on the quality of the observation". The idea of knowledge as coming from experience arose with sophist philosophers, giving rise to currents of thought that led, for example, to empiricism and the various forms of pragmatism, from which the studies that focus on practices derive. Nelson (2018), revisiting the work of Nelson and Joss (1989), returns to the original question of Blum (1986) and questions whether the scope of the practice is defined by the functionality of technology or by the use of technology by the practitioner. This is not a simple question. The pyramid of information brings in itself a tension between the sophist empiricism of its base and the socratic ideals at its apex, between sensory experiences and transcendent truths, between discovery and revelation.

Outdated conception of science

The very concept of Data, as expressed in these models, is difficult to accept. Anyone who has ever created a data collection tool will have walked in the opposite direction, starting from their knowledge to "produce" the data that their work requires. Popper (1963) wrote that it is absurd to believe that we can start with pure observations, without a theory to guide the research.

This conception of data that is "given" reflects – or induces – outdated ideals about science and its development. Frické (2009) suggests that this pyramidal representation is reminiscent of the inductivist model of growth by absorption of science, which was largely abandoned in favor of accepting that 'observational facts' are open to the possibility of revision, such as the "observational fact that the Earth that we stand on is stationary, which we can all plainly see and feel" (Frické, 2009, p. 136). According to him, one should not suppose that there is a special category of 'data', which can serve

as a foundation for everything else (Frické, 2009). Frické (2009) also notes that notably absent from Ackoff's (1980) proposal is "why". If one is to answer such question, it will be necessary "to penetrate beneath the surface, to go beyond the 'data'; and that is exactly what the hierarchy approach forbids" (Frické, 2009, p.5). Information seeking questions are, to a great extent, why questions, typically answered by a mix of facts and slices from the causal nexus tailored to the context and pragmatics of the question.

Uncritical view of technology

Even in the field of information systems, the linear data-information-knowledge relationship is not valid. Every algorithm is knowledge, which, for Ackoff (1989), is the ability to turn information into instructions. Thus, an algorithm is knowledge, as can be seen from Blum (1986). If as said by Wirth (1966), Algorithms + Data Structures = Programs, then a computer program is knowledge that produces information from data. Gadomski (2008), discussing artificial agents, reaches to similar considerations, stating that, for an assumed application domain D, an algorithm or other processing expression is considered knowledge, the data is individual information and preference relationships are used for choosing an appropriate expression of knowledge. This leads to the formula Information 'D = Knowledge D (Information D), which is valid in a Domain D where the choice of Knowledge D depends on the goal, objective or purpose of the intervention given the preferences related to the state of D,

Gadomski's proposition (2008) does not differ significantly from Brookes' (1980) fundamental equation of Information Science, whose domain, Brookes believed, is the study of the interaction between World 2 and World 3, as per Popper's definitions (Todd, 1999).

For Frické (2009), the Information Pyramid can encourage inadequate methodologies in information systems. The view that previously collected data will be promoted to information, allowing answering future questions encourages the irrational collection of data, a preventive acquisition (often not informed to users). In addition, by directing attention to the data, it disregards the importance of treatment methods. Austin and Goldwasser (2008), for example, using data from residents of Ontario, Canada, verified that residents born under the astrological sign of Pisces were significantly more likely to be hospitalized with a diagnosis of heart failure than residents born under the remaining 11 astrological signs combined. (Austin & Goldwasser, 2008, p. 298). This erroneous conclusion, they wrote, was because post hoc comparisons of the proportions of successes across different levels of a

categorical variable can result in incorrect inferences. This result, according to the authors, contributes to the growing body of statistical literature that demonstrates that data-based analysis methods can lead to misleading inferences (Austin & Goldwasser, 2008). Dealing specifically with information systems, Austin et al. (2006) and Frické (2009) consider that the conclusions obtained from data mining should deserve a degree of skepticism.

Unclear transitions and transformations

How do the transitions between levels occur? What defines and drives movement from Data to Wisdom? Is there an innate inertia that moves, consolidates and transforms Data into something that is "beyond" the Data, without contributing elements other than those that exist only in the Data themselves, until Wisdom? Data definitions do not allow this 'something else', and the model, as usually proposed, does not provide clues as to where it may be. For Georgiou (2002), the computer model postulates a linear and oversimplified progression of data for information and knowledge, and if health informatics may involve the dissemination of information, this should be seen as just a step, not the equivalent of the complex process of generating knowledge.

As already commented, it is necessary to question whether the movement is unidirectional, starting from data, seen as the layer supporting the model. Tuomi (1999) suggests that the direction of movement between concepts in the model depends on user activity. Knowledge researchers put data in context to create information; knowledge workers start with knowledge to create information, required to create data; knowledge and information must exist as prerequisites for creating specific contexts, structures and semantics that facilitate data creation. For this author, Data are more important than Knowledge, proposing an inversion of the hierarchy, in line with Rowley (2006) and opposite to Frické's considerations (2009). Valuing knowledge as something to be mobilized or created is a means of shaping "how we know what we know" and understanding what types of knowledge are possible. In addition, the diversity of definitions and conceptualizations of the hierarchy suggests that values play an important role. There is undoubtedly an inextricable connection between epistemology - the nature of knowledge - and axiology - the ways in which values are attributed -, in the formation of perceptions for creation and use of knowledge.

Not all knowledge is born from data

As Frické (2009) states, all knowledge is propositional in form and, given an adequate expressive language, can be written and recorded, and can be stored in databases, which may even be called Knowledge Bases. The know-

how is different. If certain expressions of know-how can be articulated as procedural rules, usually in the "if-then" format, other expressions do not. It does not seem reasonable for anyone to learn how to ride a bicycle following instructions written in a textbook or operations manual. Tacit knowledge can be explained, but it cannot be inferred from this statement that what has been recorded is knowledge, as can be seen in the excerpt below, which documented perceived benefits of the adoption of Knowledge Management practices at Itaipu Binacional, a brazilian-paraguayan company which operates the world's largest power plant:

Greater transfer of tacit and explicit knowledge among employees, through electronic knowledge bases (e.g., repositories of best practices and lessons learned, knowledge map of employees), communities of practice, and discussion groups associated with the generation of knowledge in a production environment, without relying on the formal teaching process. Activities related to dam safety, for example, involve eminently technical knowledge and "learning takes place much more in the work field than in training" (Moreno & Lima, 2013, p. 12)

If the data-information-knowledge sequence is worth, then tacit knowledge should be translated into data, starting the cycle. The excerpt makes aware that this may not be an appropriate method.

V. THE UTILITY OF THE PYRAMID

Should the Information Pyramid be set aside? Maybe that is a hasty conclusion. As a representation of the varied relationships between the elements it presents, the pyramid leaves much to be desired. Man and society, for example, are lacking, despite the attempts of authors such as Barreto (1994, 2002) or Choo (2006). As a schematic representation of the treatment of information, the original subject of Ackoff (1989), it disconsiders the knowledge that "enters" - as an algorithm - in the process of transforming data into information.

However, it can be an instrument of reflection. If developing the capacity for reflection is one of the main objectives of the teaching-learning process, it can have a role to play in the professional training of managers and information scientists. In the early years of undergraduate courses, with students still unprepared for further discussions, this simplicity is timely.

There are numerous variations of this pyramid. A comparative study of variants can help to understand different perspectives of both the elements/concepts and

the underlying processes/transformations and even the application context. As Rowley's (2007) work attests, if there are genuine and possibly substantial differences in representations and concepts, there is an important core and similarities.

Be the case with Data. Although usually the pyramids presented in articles or books start with 'Data', there are divergences. Choo (2006), in a semiotic approach, places "Signs" as the basis of his representation. It is from these signs that derive the Data, through the pathways of perception and selection (as mental processes), these influenced by previous learning and the beliefs of individuals, and physical structuring (material environment and/or technical requirements)

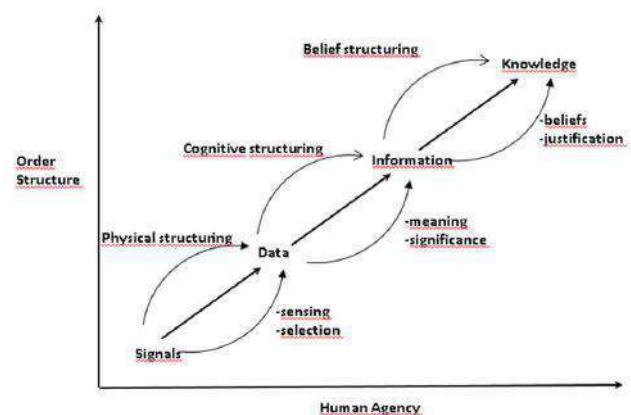


Fig.1: The hierarchy of knowledge according to Choo (2006)

Source: adapted from Choo (2006, p.132)

If both Choo (2006) and Barreto (2002, 1994) speak of the human, the human dimension is different in each case, which is more evident when observing the top of the hierarchy. If Choo stop in Knowledge, Barreto (2002) goes to Wisdom. Choo (2006) builds a model appropriate to management. Management implies command and control, according to Fayol (1989, p. 26). It also implies a collective process – which does not mean that it is a democratic, fair or egalitarian process. Barreto (2002) focuses his model on Man - not for any other reason he anchors his proposal in Hanna Arendt's The human condition (Barreto, 1994). Even though this man or woman lives in community, Barreto speaks to the individual. Juxtaposition and comparison of these different representations allows relevant discussions about information and knowledge as an individual and/or social process, about technology and society, but also about facts, values and ethics, usually understood as dissociated, in a positivist position not always explicit that authors such as Putnam (2008) and Sen (1999) criticize.

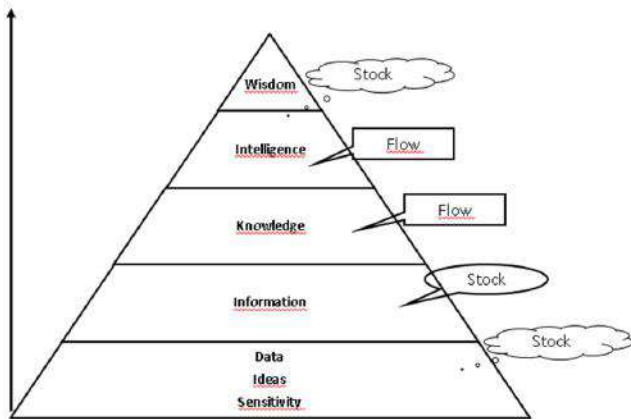


Fig.2: The pyramid of flows and stock of Barreto

Barreto (1994) – whose reading of the pyramid is not exempt from some of the criticisms that arise here – considers that the definitions relating information to the production of knowledge associate this phenomenon with the development of the freedom of the individual, his group and society. Information is a modifying instrument of individual and collective consciousness. We return to the platonic ideal, to *Summum Bonum*, to Wisdom and to issues such as values, ethics and ideals, which are foundations of action. Cornelius (2014) links ethical decisions to informational processes by questioning: how can we determine how we should act. He considers that this is usually posed as a question of ethics, of determining what constitutes good behavior, but it also requires answering associated questions, which are information questions.

The question ‘should I steal to give to the poor?’ It’s an ethical issue. The question ‘how should I steal?’ may be an ethical question, but it is also a question of information, and the answer would include much of what we commonly call ‘information’ about the means, which can be quite general, and also about very particular things that relate to the opportunities I may have to steal (Cornelius, 2014, p. 181).

These considerations arise also in Zeleny (2006). According to him, it is not only important to consider an integrated and mutually enhanced system of the autopoietic self-production cycle of information and knowledge, but that one considers the connection action, knowledge and information, echoing a pragmatic proposal, for those who know and act are inseparable (Outhwaite & ore, 1996, p. 598). It also considers that a process can include its entries, but no single entry can include its process; and that the goal is to produce more knowledge, not more information; it concludes that knowledge management should include information management, but

that information management cannot include knowledge management. Zeleny's (2006) goal is to establish a pragmatic, practical and useful definition of wisdom, wishing that "wisdom becomes – such as knowledge and information – a manageable resource for corporate efficiency, effectiveness, explainability and ethics". These discussions, and several others, can be instigated by a critical discussion of the Pyramid of Information. Thus used, critically and carefully, the pyramid serves the purpose of learning, perhaps addressing Ackoff's (1989) wishes.

VI. CONCLUSION

Data, Information and Knowledge are incorporated into the discourses of the most diverse actors. They are now part of the most varied scientific models, assuming a central role in governance and management models, inducing behaviors in organizations of various types. They often appear in the media, often in superlative statements. They are key to flourishing market for products and services and are the subject of discussions about public policies. It is important to not only discuss these concepts, but also try to understand how they are incorporated into the daily practices of people and organizations. Unlike genes, atomic particles or mathematical conjectures, data, information and knowledge are intertwined in acting and are elements of the simplest or the most complex activities and decisions in the everyday life of individuals and organizations.

The hierarchical representations of the relationships between data, information, knowledge and others elements, when present, are unable to adequately represent, even in a simplified way, the complex processes it intends to subsume. However, this representation can still be an instrument of learning, since used critically, supporting discussions about the complexity and circularity of the phenomena that this representation tries to express.

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Reducing the Cost of Welding Paste in the Surface Assembly Technology (SMT) Process

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Welding process, Costs.

Abstract— The Surface Mounting Technology (SMT) industries have overcome many challenges over the past few years with regard to their position in relation to environmental issues and cost reduction. One of the concerns lies in the fact that the welding procedures for electronic components incorporate lead, which poses risks to operators involved in the production processes, as well as a high value in the cost of solder paste. The most common alloy is lead free, it is a tin-based alloy, which replaces lead with 3.9% silver and 0.6% copper. The alloy is known as (SAC) Sn3,9Ag0,6Cu. The material is applied to the process used in the manufacture of about 70% of the computer boards currently produced. The need to migrate welding processes to this new type of technology requires companies to adopt a strategy of change appropriate to the maintenance of current processes and their gradual replacement by lead-free welding processes and their implications for costs. The main objective of this dissertation is to present the development of the solder process in local paste in order to reduce production costs, maintaining the quality and reliability of the product, especially the main plates of Televisions. This study, in addition to presenting a bibliographic review involving the SMT process, will explore the concepts about the types of solder pastes so that the reader can have a better understanding of what will be proposed as well as, the description of the case study in a factory in the Manaus Industrial Pole (PIM). The results show that the local industry seeks in a planned and consistent way to process innovations and process cost reduction. The cost reduction mainly includes the reduction in the cost of raw material, the main competitive advantage of Chinese companies, usually 30% cheaper than that of competitors (despite the inferior quality). It is concluded that it is possible to evidence the significant reduction in the costs of solder paste in the process of surface assembly technology (SMT) with its manufacture made locally, reducing transportation cost, importation costs and stock (transit and factory).

I. INTRODUCTION

new standards for the control and elimination of substances considered harmful to the environment have

been edited, causing several industrial sectors to review projects and specifications in order to adapt to these new standards (TSUNG-NAN, 2012).

One of the concerns lies in the fact that the welding procedures for electronic components incorporate lead, which poses risks to operators involved in the production processes, as well as a high value in the cost of solder paste.

The most common alloy is lead free, it is a tin-based alloy, which replaces lead with 3.9% silver and 0.6% copper. The alloy is known as (SAC) Sn3,9Ag0,6Cu. The material is applied to the process used in the manufacture of about 70% of the computer boards currently produced. For processes that use higher temperatures, there are two other alloys: Sn0.7Cu, a tin alloy with 0.7% copper, and SN3.5Ag, which has 3.5% silver (HWANG, 2014; ALMEIDA et al., 2013).

The need to migrate welding processes to this new type of technology requires companies to adopt a strategy of change appropriate to the maintenance of current processes and their gradual replacement by lead-free welding processes and their implications for costs.

Manufacturing objectives are to maximize quality and productivity while controlling costs. Therefore, choosing the right solder paste can achieve the highest process consistency and solder quality. The quality of manufacture can be improved by choosing the paste with good performance in the materials, geometry and heating processes used in the manufacture of a product. Yield can be maximized by choosing a solder product that accommodates the ideal deposition and heating methods.

There are several types of weld products with differences in wetting characteristics, void control, flow residues, alloy strength, alloy flexibility and other performance measures that can play a significant role in achieving quality, yield and cost goals (LAURICELLA, 2010).

Alloy requirements must be assessed so that they can meet all product procedures. Flow types must be identified correctly. In the process, flows with unacceptable criteria are removed from consideration. Then, issues such as difficult-to-weld surfaces, rapid reflux conditions, cleaning options and concerns for voiding the weld joint must be considered before choosing a paste (SILVA et al., 2017).

When choosing a solder alloy, note the lead content, the melting temperature, the size of the alloy powder particles and the tensile strength.

Solder paste technology has evolved from water-soluble to the unclean and lead-free to lead-free variant. This technological evolution is driven by miniaturization, cost reduction and legislation that requires the use of lead-free and halogen-free materials. The industry is also gaining more experience with lead-free alloys, with less

silver content, lower costs and better performances (KEITH, 2011).

With the increasing precision of electronic products and the trend of lead-free soldering, the components of the adhesive are becoming increasingly minute, so the quality of solder paste printing is becoming increasingly important. Solder Paste Inspection (SPI) can effectively guarantee good solder paste print quality and greatly reduce the possible rate of defects in finished products (LAU, 2018).

The aforementioned author also mentions that the introduction of the SPI can effectively reduce the unqualified rate of the original finished Printed Circuit Board (PCB) by more than 85%; the cost of rework and scrap is greatly reduced by more than 90%, and the quality of manufactured products is significantly improved. As a means of quality process control, quality risks can be encountered in time before reflux welding, so that there is almost no possibility of repair and scrap costs, which effectively saves costs. The combination of SPI and Automatic Optical Inspection (AOI), through real-time feedback and optimization of the SMT production line, can make production quality more stable, significantly reduce the unstable experimental production stage that should be experienced when the new product is introduced and the corresponding cost loss is more economical.

Welding manufacturers today understand their customers' demands and offer a range of solder pastes that can be used at reasonable prices to help the industry manufacture highly efficient and durable electronic items. Only the best weld quality can help the electronics industry to produce products that meet industry standards at a reduced cost (OLIVEIRA, 2012).

Given the above, the following problems arise: What are the materials with indirect costs of transport, taxes and stock that make a new source of raw material viable? Are there reliable local suppliers with adequate quality?

Technological advances have proposed to industries a continuous improvement of their processes. Nowadays you can create new products and send them to the consumer market within the shortest amount of time. This type of process fits very well in the electronics segment as it is a consumer product on the rise and depends directly on technological advances to remain in the market.

In view of the great market demand, companies seek to supply the largest number of products and the shortest time. For most companies, this is only possible with the improvement of the quality of their processes, forcing the production chain to be more efficient, thus minimizing losses resulting from production failures due to non-quality. In this way, it is understood that the continuous

improvement of the production process has as main objective to reduce the losses resulting from operational failures, or not, of the quality of the materials, and this process seeks to reach all the manufacturing sectors.

The Manaus Industrial Pole (PIM) is a model of economic development implemented by the Brazilian government with the aim of enabling an economic base in the Western Amazon, promoting the best productive and social integration of this region of the country, guaranteeing national sovereignty over its borders. Several PIM companies use suppliers who are responsible for the certification of the components used in production. Each component manufacturer bears the costs of certification of its goods and, in order to obtain the final certification report for the finished product, the company should invest in a laboratory for conformity analysis, that is, evaluate the final product and issue a certificate of conformity that certifies the absence or presence, within specific limits, of restricted substances.

It is evident that most of the electronic components have traditionally been welded with the tin and lead alloy, the latter being an element that has high toxicity, whose residues produced during their obtaining and recycling of the alloys can contaminate water, air and the soil and have a high cost.

The results of this investigation and the case study prove the relevance of this study, since the greatest impact will be the reduction of failure rates, elimination of rework costs, increased productivity and reduced industrial costs, among others. In the current global and technological scenario, the development of micro components does not allow errors, under penalty of increasing all costs involved in the assembly and manufacturing process. As a result, organizations increasingly seek excellence in their processes, thus ensuring highly positive results in quality indicators.

Thus, the main objective of this article is to present the development of the solder process in local paste in order to reduce production costs, maintaining the quality and reliability of the product, especially the main plates of Televisions.

II. MATERIALS AND METHODS

For the development of this research, the methodological procedure was adopted regarding the path taken by the author to achieve the proposed objective. This section will explain the procedures and instruments used to carry out the research.

Qualitative research was used, as this type is not concerned with numerical representativeness, but with

deepening the understanding of a social group, an organization, etc.

Nascimento (2008) emphasizes that qualitative research does not seek to enumerate and / or measure the events studied, nor does it use statistical instruments in the analysis of data, it involves obtaining descriptive data about people, places and interactive processes by the direct contact of the researcher with the situation studied, trying to understand the phenomena from the perspective of the subjects, that is, the participants of the situation under study.

Qualitative research is concerned, therefore, with aspects of reality that cannot be quantified, focusing on understanding and explaining the dynamics of social relations.

In order to follow the above objectives, the investigation will combine the different types of investigation through bibliographic, exploratory and descriptive studies, as well as the case study.

This study, in addition to presenting a bibliographic review involving the SMT process, will explore the concepts about the types of solder pastes so that the reader can have a better understanding of what will be proposed.

For Gil (2012, p. 115) "the analysis of documents or analysis of contents consists of the systematic examination of reports or documents as sources of data".

The present research consisted of bibliographic surveys used as a study source for carrying out the work, without the author's interference in the result.

In this way, bibliographic research is one in which primary and secondary documents are used to produce the research.

For Nascimento (2008, p. 37) "the main form of data collection is reading (books, magazines, newspapers, websites, CDs, etc.), which is certainly used for all types of research. This technique is also called bibliographic research".

An exploratory procedure will also be used, as an integral part of the main research, as the preliminary study carried out in order to better adapt the measurement instrument to the reality that is intended to be known.

According to Nascimento (2008, p. 39) in other words:

[...] exploratory research, or exploratory study, aims to know the study variable as it presents itself, its meaning and the context in which it is inserted. It is assumed that human behavior is better understood in the social context where it occurs.

This type of research aims to provide greater familiarity with the problem, in order to make it more

explicit or to build hypotheses. Thus, the choice of this method is justified according to the purpose of the research, which is to present the development of the solder process in local paste in order to reduce production costs, maintaining the quality and reliability of the product, especially the Televisions main boards ..

Descriptive research requires a lot of information from the researcher about what they want to research.

Gil (2012) points out that descriptive research has as its primary objective the description of the characteristics of a given population or phenomenon, or else, the establishment of relationships between variables.

Descriptive studies can be criticized because there may be an exact description of the phenomena and facts.

As Yin (2010) points out, the use of the case study is appropriate when it is intended to investigate the how and why of a set of contemporary events. The author asserts that the case study is an empirical investigation that allows the study of a contemporary phenomenon within its real-life context, especially when the limits between the phenomenon and the context are not clearly defined.

III. RESULTS

3.1 Process

The main parameters of an effective solder paste printing process are as follows:

- Squeegee speed
- Squeegee pressure
- Squeegee angle
- Stencil separation speed
- Stencil cleaning
- Stencil and squeegee condition
- PCB support
- Printing course
- Type, storage and handling
- Inspection (2D / 3D)

1) Squeegee speed

The speed of travel of the squeegee determines how much time is available for the solder paste to “roll” through the stencil openings and on the printed circuit board pads. Typically, a setting of 25 mm per second is used, but this varies, depending on the size of the openings inside the stencil and the solder paste used.

2) Squeegee pressure

During the printing cycle, it is important to apply enough pressure over the entire length of the squeegee

blade to ensure clean cleaning of the stencil. Low pressure can cause paste "stains" in the stencil, low deposition and incomplete transfer to the PCB. Too much pressure can cause “slipping” of the paste from larger openings, excessive wear on the stencil and squeegees and can cause “bleeding” of the paste between the stencil and the PCB. A typical setting for squeegee pressure is 500 grams of pressure per 25 mm squeegee blade.

3) Squeegee angle

The squeegee angle is normally set at 60 ° by the supports to which they are attached. If the angle is increased, this can cause the holder paste to be removed from the stencil openings and therefore less solder paste is deposited. If the angle is reduced, you can leave a solder paste residue on the stencil after the squeegee has finished printing.

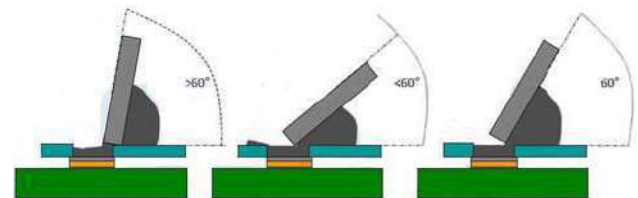


Fig.1: Effect of the squeegee angle.

Source: Case study, 2019.

4) Stencil separation speed

This is the speed at which the PCB separates from the stencil after printing. A speed setting of up to 3 mm per second must be used and is governed by the size of the openings within the stencil. If this is too fast, the solder paste will not be completely released from the openings and the formation of high edges around the deposits, also known as “dog ears”, can be seen in Figure 2.

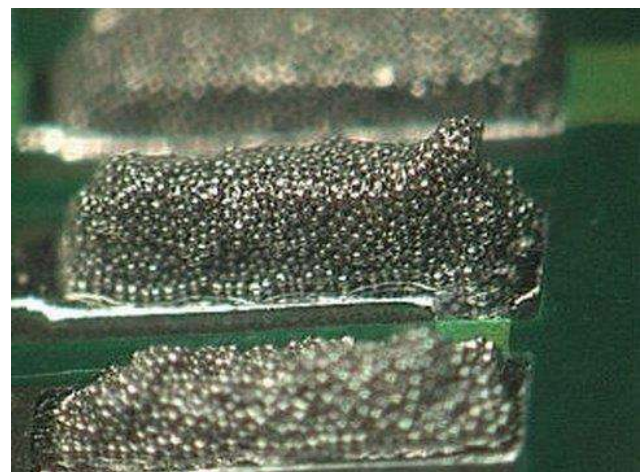


Fig.2: Example image showing high points in the solder paste deposits known as 'dog ears'.

Source: Case study, 2019.

5) Stencil cleaning

The stencil must be cleaned regularly during use, which can be done manually or automatically. Many automatic printing machines have a system that can be configured to clean the stencil after a fixed number of prints using lint-free material applied with a cleaning chemical like IPA. The system performs two functions, the first is cleaning the bottom of the stencil to stop smearing, and the second is cleaning the openings using a vacuum to stop the blockages.

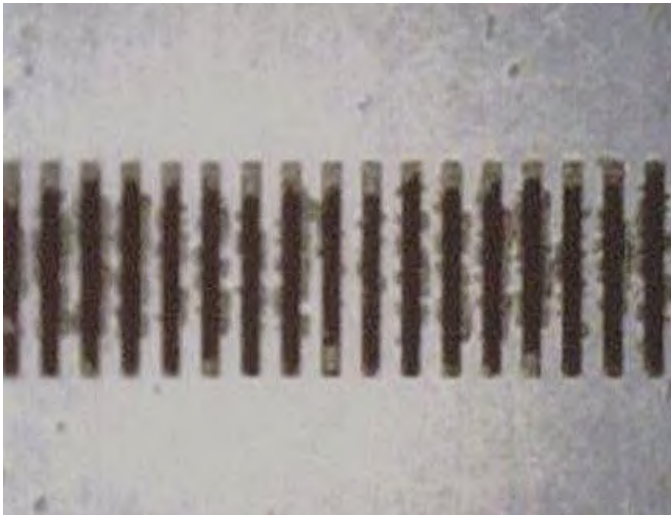


Fig.3: Solder paste 'bleeding' at the bottom of the stencil.

Source: Case study, 2019.

6) Stencil and squeegee condition

Stencils and squeegees need to be carefully stored and maintained, as any mechanical damage can result in unwanted results. Both should be checked before use and thoroughly cleaned after use, ideally using an automated cleaning system to remove any solder paste residue. If any damage to the squeegees or stencils is observed, they must be replaced to ensure a reliable and repeatable process.

7) PCB support

This is an important factor in ensuring that the PCB is kept flat against the stencil during the printing process. If the PCB is not fully supported, it may cause printing defects, such as a paste deposit and bad stains. PCB stands are usually supplied with fixed height printing machines and programmable positions to ensure a consistent process. Adaptable PCB holders are also available with varied designs that mold to the PCB and are useful for double-sided assemblies.

8) Printing course

This is the distance the squeegee travels through the stencil and it is recommended that it be at least 20 mm beyond the most distant opening. The distance after the

most distant opening is important to allow enough space for the paste to roll on the return stroke, as it is the rolling of the solder paste bead that generates the downward force that directs the paste into the openings.

9) Type, storage and handling

The solder paste is essentially a powder solder suspended in a thick medium called a flux. The flux acts as a temporary adhesive, holding the components in place until the welding process melts the weld and forms the electrical / mechanical connection.

Solder paste is a 'thixotropic' material and requires energy to be applied in the form of movement of the print head to change viscosity and flow evenly through the stencil openings. A frequently used term is solder paste 'rheology', which describes how solder paste forms a block when no energy is applied, but changes to a more fluid material when energy is applied.

10) Inspection (2D / 3D)

To verify the process, automatic inspection can be used to accurately check for solder paste deposits. There are two types of solder paste inspection available: 2D inspection that checks the paste deposit area and 3D inspection that checks the volume of the paste deposit.

3.2 Approval methodology for solder paste used

The qualitative and quantitative validation took place due to the defects presented in the welding inspection (SAOI) in PPM, according to the IPC-610 standard.

The measurement method was calculated using the following formula:

$$\text{PPM} = (\text{Number of defects} / (\text{plates produced})) * 1,000,000.$$

3.2.1 Defects considered by the SAOI optical inspection machine:

Displaced - The component must have its terminal up to 50% on an island (Figure 4).

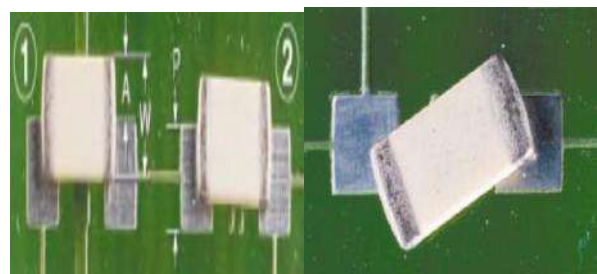


Fig.4: Displaced defect.

Source: Case study, 2019.

Excess weld - The amount of weld may be greater than the size of the component, but it cannot be extend over the component body.

Insufficient solder - The solder did not connect to the component.

Solder ball - Solder balls that can compromise the correct performance of the circuit.

Short circuit - Short circuit, solder connection between two points that should not be electrically connected.

Missing - Missing component.

Component inverted - Component with polarity, mounted inverted.

3.3 Profile of the welding oven

The melting temperature profile is defined by the relationship of temperature and heating time. There are two types of basic temperature profiles: Ramp-Soak-Spike (RSS) and Ramp-to-Spike (RTS). The RTS temperature profile is suitable for most applications to improve weld performance. The temperature profile is appropriate when mounting and has a large thermal mass or a large variation in ΔT .

The temperature profile should be a cross reference between the component manufacturer's recommendation to ensure that the temperature does not exceed the maximum temperature in all materials. It is advisable to check the thermal sensitivity of the components according to the specification of each supplier or to use the IPC-9502, before defining a reflow profile.

As a defined process has already been presented, this means that all these issues have already been verified, it is only necessary to apply the manufacturer's recommendation.

The weld manufacturer recommends a reflow profile for the best welding performance, as shown in Figure 5.

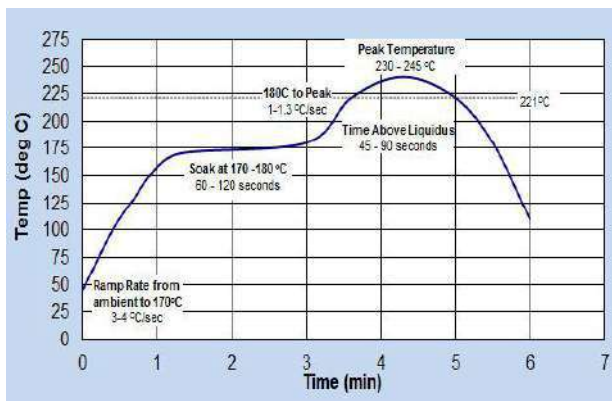


Fig.5: Recommendation of the remelting profile.

Source: Case study, 2019.

Cunha (2013) mentions the types of oven profiles for welding:

Ramp Up: The portion of the profile where the plate is heated from room temperature at a predetermined rate. Controlling the ramp is necessary to prevent thermal damage to components.

Preheat / Soak Time: Time is monitored to ensure thermal balance across the board. The preheat portion is equal to = t_{min} to t_{max} .

Time Above Liquidus: This is the time that the solder alloy is in a liquid state. The plate must remain at a predetermined time in this phase to ensure that all areas of the plate will be properly fused.

Time Above Peak: Time in which the measured component reaches the highest temperature.

3.4 Local solder pastes

In the case study presented, two folders produced locally were developed, the AIM produced by ALFATEC and ALPHA from Apha Assembly, with international specifications, composition and performance. Table 1 shows the costs per kilogram of the local pulp.

Table 1: Costs per kilogram of local pulp.

UNIT COST (US\$)	
AIM	ALPHA
71,5	65

Source: Case study, 2019.

Folders are used worldwide in large companies. Pastes are Lead Free with lead-free composition. The L / F composition is as follows: 96.5Sn / 3.0Ag / 0.5Cu.

It should be noted that the paste imported from Korea used previously was HEESUNG. The FOB cost of this paste is \$ 46.56. This cost does not include transportation costs, taxes, inventory costs and services. The cost analysis of this case study was based on an import of 360 kilos of paste. The dollar rate used was R \$ 3.6874. The total cost of the weld, considering all expenses, is US \$ 92.71. Almost double the FOB value of US \$ 46.56, as shown in Table 2.

Table 2: Total expenditure costs

TAX	COST (R\$)	TAX	COST (R\$)
DI	360 Kg	SEGURO INTERNACIONAL	37,32
II	13.383,80	SUFRAMA	340
PIS	2.007,57	ARMAGENAGEM	554,26
COFINS	9.225,26	DISCONSOLIDAÇÃO	202,81
SISCOMEX	214,5	DESPACHANTE	76,54
FRETE INTER.	33.749,30	FOB	61.812,00
FRETE LOCAL	225,15	FTI	1.236,24
SUB Total	58.805,58	SUB Total	64259,17
TTL DESPESAS BRL	123.064,74	TTL DESPESAS USD	33.374,40

Source: Case study, 2019.

The savings of this localization process include the difference in the final value of the imported solder paste, the costs of inventory in transit and local in the year value of US \$ 698,834.57 in the first year. Economy of local stock and transit considering the value of US \$ 92.71 / Kg. Direct daily delivery to the production process (Table 3).

Table 3: Economy of the local stock and transit process.

ESTOQUE	QTDE (Kg)	US\$
LOCAL	2.000	185.420,00
TRANSITO	495	45.891,45
TOTAL		231.311,45

Source: Case study, 2019.

The annual savings considering the use of ALPHA Solder with a consumption of 1,406 Kg / Month is shown in table 4.

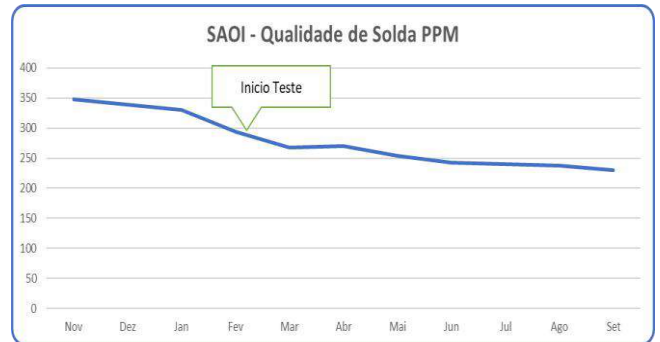
Table 4: Annual savings on the use of ALPHA solder.

Consumo mês (Kg)	Custo HEESUNG (US\$)	Custo ALPHA (US\$)	Economia mês (US\$)	Economia Ano (US\$)
1.406,00	130.350,26	91.390,00	38.960,26	467.523,12

Source: Case study, 2019.

The test carried out in the process was evaluated according to IPC-610-A Weld quality indicator, automatically evaluated was as shown in the result of graph 1.

Nov	Dez	Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago	Set
348	339	330	294	268	270	254	243	240	238	230



Graph 1: Result of tests performed and Defects in PPM.

Source: Case study, 2019.

IV. CONCLUSION

At the end of the work, it is possible to evidence the significant reduction in the costs of solder paste in the process of surface assembly technology (SMT) with its manufacture made locally.

The solder paste, which mainly serves as a means of connecting the interconnection features of the device and the PCB, is fundamental to the product's performance in an SMT line. The poor impression of the solder paste results in a large number of defects. The components of a solder paste are designed to provide excellent reflow and print characteristics. When choosing a solder paste, it is important for the buyer to ensure that the paste offers long hours of printing, has the right particle size for the tone of the components and is of the appropriate flow type depending on the assembly application.

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Occurrences of disasters involving rains in the state of Tocantins

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Keywords— Natural Disaster; Flooding;
Flooding; Flood.

Abstract— The Natural disasters are the result of the impact of an extreme or intense natural phenomenon on a social system. In Brazil, the most common types of disasters are related to lack or excess water, such as drought, floods, floods, floods. The agencies responsible for monitoring natural disasters in Brazil are the National Secretariat for Protection and Civil Defense (SEDEC), the Ministry of Regional Development, representative of SINPDEC - National System of Protection and Civil Defense. The Integrated Disaster Information System - S2ID integrates several SEDEC products, and aims to qualify and provide transparency to risk and disaster management in Brazil. It also has the National Center for Monitoring and Warning of Natural Disasters (Cemaden), which works in partnership with other institutions and allows the early sending of natural disaster alerts to risk areas located in all regions of the national territory.

I. INTRODUCTION

Natural phenomena are present on planet Earth from the beginning, they act according to the natural laws of our planet, but with the emergence of homo-sapiens, these phenomena could then cause damage to the societies of our species, and when these phenomena cause harm to us, these become called natural disasters.

Natural disasters in general can be of biological, geophysical, hydrological, meteorological, climatological origin, or even in the worst situations a combined of one or more types, causing damage to health, material damage or even the loss of human lives, being in Brazil the most common to occur climatological, hydrological or meteorological disasters, involving lack or excess water.

This article aims to identify events of floods, floods and floods, in the S2ID - National Disaster Information System for the state of Tocantins, mapping the municipalities with the highest occurrences, and also with higher risks of future occurrences of new disasters.

II. BIBLIOGRAPHIC REVIEW

2.1 NATURAL DISASTERS

The National Institute of Space Research (INPE) defines natural disasters as "a result of the impact of an extreme or intense natural phenomenon on a social system, and that causes serious damage and damage that exceeds the ability of those affected to live with the impact".

The Institute proposes the following classification for natural disasters: biological (epidemics, insect infestations, animal attacks); geophysicists (earthquakes, volcanoes, mass movement without water); (droughts, extreme temperatures, fires); (floods, mass movements with water); weather (storms) [1].

According to [2], in order for a natural disaster to occur, a combination of four factors is necessary: the occurrence of a natural threat; an exposed population; the conditions of social and environmental vulnerability of this population; and insufficient capacities or measures to reduce potential risks and damage to the health of the population. The threat generated comes from the quality of physical processes that are generated by the dynamics of nature, according to its

geographical location, magnitude, intensity, frequency and probability.

2.1.1 DISASTERS AND CRITICAL EVENTS INVOLVING RAINS

NOBRE, 2017) cites as the most common elements that trigger natural disasters in Brazil:

Heavy and prolonged rains, storms, gales, hail, droughts, extreme air temperatures and humidities and hangovers, which cause landslides on hillsides, floods, floods, floods, collapse of subsistence crops, vegetation fires, coastal erosion, acute episodes of water and air pollution, water supply collapses and epidemics.

In Brazil, most of these disasters are associated with lack of water, such as drought, or excess of it, such as heavy rains, which generate floods [3].

"The terms associated with floods are: flood, flood, flood, gradual flooding, flash flooding, flooding, riverside flooding, urban floods, flash floods, and more [4]."

The [5], defines as Flood, when the water flows in its course reach such magnitude that they can overcome the discharge capacity of the gutter and extravasate to marginal areas, these being the areas that receive these excess waters, and are called as floodplain, floodplain or larger bed. Floodism is defined as concentrated surface flow of water, and with high transport energy. And floods, also called flooding, is given as the temporary elevation of the water level in a drainage channel due to increased flow or discharge, in the case of floods the water does not go out, as occurs in floods.

When areas occupied by the population, whether for housing, commerce, industry, transport, and other urban uses, are hit by a flood, this flood is called Urban Flood also defines the concept of Riverside Flooding, this occurs when the excess of the volume of water that cannot be drained occupies the floodplain flooding according to the topography of the areas near the rivers [6]

2.2 THE NATIONAL DISASTER INFORMATION SYSTEM

In Brazil, the National Secretariat for Protection and Civil Defense (SEDEC), an agency of the Ministry of Regional Development, is the body responsible for coordinating civil protection and defense actions throughout the national territory, and is a representative of the Central Body of SINPDEC - National System of Protection and Civil Defense [7].

The National System of Protection and Civil Defense (SINPDEC) is composed of organs and entities of the federal public administration, the States, the Federal District and municipalities and public and private entities of

significant action in the area of protection and civil defense. SINPDEC will be able to mobilize civil society to act in a state of emergency or a state of public calamity, coordinating logistical support for the development of civil protection and defense actions [7].

The Integrated Disaster Information System - S2ID integrates several products of the National Secretariat of Protection and Civil Defense - SEDEC, with the objective of qualifying and giving transparency to risk and disaster management in Brazil [8].

In S2ID, there is a fully computerized process where it is possible to record disasters that occurred in the municipality/state, consult and monitor the processes of federal recognition of emergency situation or state of public calamity; consult and monitor the processes of transferring resources to response actions; consult and monitor the processes of transferring resources to reconstruction actions and seek information on occurrences and risk and disaster management based on official data sources [8].

The S2ID also has the PLANCON Module - Municipal Contingency Plans, for the preparation of contingency plans of the municipalities and the possibility of identification by the whole society, of the municipalities in Emergency Situation and Public Calamity State recognized by the Secretariat [8].

2.3 SUSTAINABLE DEVELOPMENT GOALS

According to the 2030 Agenda Platform, in New York, UN member states met and adopted the document: "Transforming Our World: The 2030 Agenda for Sustainable Development", where they pledged to take bold and transformative measures to promote sustainable development over the next 15 years without leaving anyone behind [9].

This document consists of a Declaration, in a table of results, the 17 SDS – Sustainable Development Goals and its 169 goals, in a section on means of implementation and global partnerships, as well as a roadmap for monitoring and review. The SDGs are the core of the Agenda and should be achieved by the year 2030, they are integrated and indivisible, and blend, in a balanced way, the three dimensions of sustainable development: economic, social and environmental [9].

Among the 17 objectives, number 13 is titled "Action Against Global Climate Change", and aims to take urgent action to combat climate change and its impacts. According to the [10], goal 13.1 was completed: Strengthening resilience and adaptability to risks related to climate and natural disasters in all countries, which has as indicators: 13.1.1 Number of deaths, missing persons and people directly affected attributed to disasters per 100,000

inhabitants; 13.1.2 Number of countries adopting and implementing national disaster risk reduction strategies in line with the Sendai Framework for Disaster Risk Reduction 2015-2030; 13.1.3 Proportion of local governments adopting and implementing local disaster risk reduction strategies in line with national disaster risk reduction strategies [10].

2.4 NATIONAL DISASTER PREVENTION PROGRAMS

According to [11], "natural disasters occur in regions where populations are most exposed and vulnerable to extreme climate and hydrometeorological events."

From the disasters that occurred in the second half of the first decade of the 21st century, it became indispensable to have an alert system to deal with natural disasters, until then no body of the federal sphere monitored these processes in an integrated and interdisciplinary manner, so government actions were limited to mitigating the consequences of natural disasters [11].

In July 2011, the National Center for Monitoring and Warning of Natural Disasters (Cemaden) was created, by Presidential Decree No. 7,513, an agency linked to the Ministry of Science, Technology, Innovations and Communications (MCTIC).

Cemaden operates 24 hours a day, without interruption adopts a specialized technical-scientific structure, developing scientific, technological and innovation capacity to continuously improve the alerts of natural disasters and has as main objective of the Institution to carry out the monitoring and issue alerts of natural disasters that support safeguarding lives and reduce the social, environmental and economic vulnerability arising from these events. Cemaden works in partnership with other institutions to complement the network of monitoring tools, and the results of research and tools developed by cemaden's network allow the early sending of natural disaster alerts to risk areas located in all regions of the national territory [12].

III. MATERIALS AND METHODS

Develop a bibliographic research on Natural Disasters

and the National Programs for Disaster Prevention and how these programs relate to the proposals of the UN SDS13.

Search on websites of the Federal Government of Brazil, the Ministry of Regional Development on the programs in practice that aim to monitor and prevent natural disasters. Also research the proposal of the 17 SDGs – Sustainable Development Goals, present in the UN 2030 agenda, and collect data on the progress of objective number 13 in Brazil.

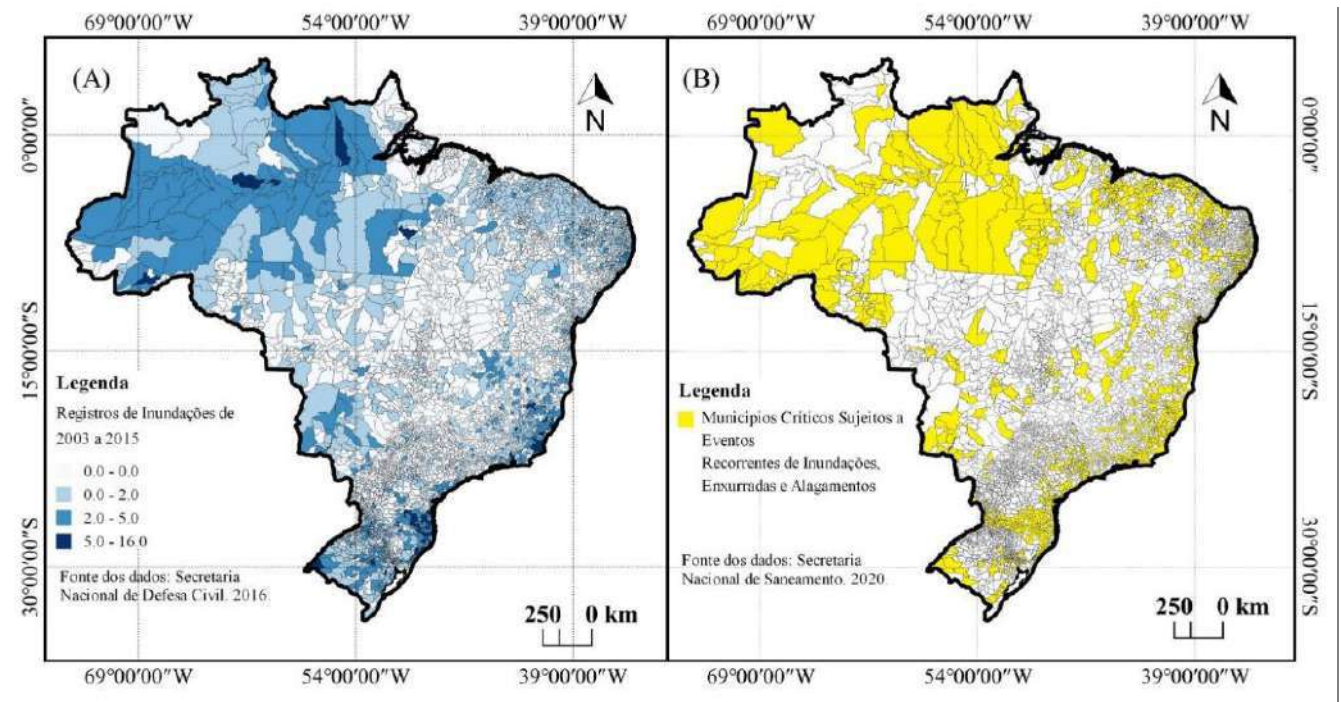
Search the SEDEC - National Secretariat for Protection and Civil Defense, and select data of floods, floods and floods, by type of disaster and document, of the municipalities of Tocantins, data taken from the disaster information system, S2ID and SNIS in the rainwater module for Tocantins; Filtered for Tocantins, types of events, types of documents; each year with available data; the data were tabulated using the Excel program for analysis. Exploratory analysis of the data and application of statistical methods, to analyze the periods and places of higher incidences of hydrological disasters, also the means of communication by which it was cataloged.

Finally, in order to allow a spatialized analysis of the information, these data were georeferenced and associated with digital files structured in GIS, available in the Geographic Database of the State of Tocantins.

Search the SEDEC - National Secretariat for Protection and Civil Defense, and select data of floods, floods and floods, by type of disaster and document, of the municipalities of Tocantins, data taken from the disaster information system, S2ID.

IV. RESULTS AND DISCUSSION

In the map below, made available via the National Sanitation Information System (SNIS), it is possible to observe the regions with the highest number of flood records throughout Brazil between 2003 and 2015, as well as critical municipalities subject to recurrent events of floods and floods.



4.1 S2ID - NUMBER OF EVENTS

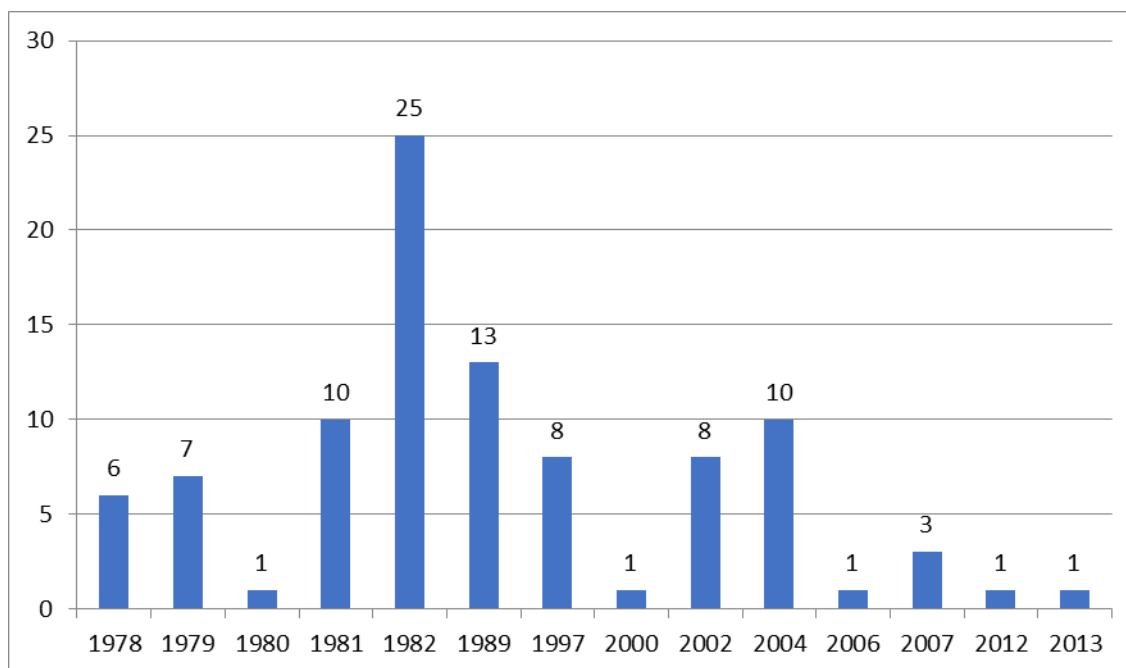
In S2ID – Integrated Disaster Information System, after the research for natural disasters involving Floods, Floods and Floods, in the state of Tocantins for all municipalities and available years, information was found from the year 1978 for flood-type disasters, 1974 for flood disasters and 1997 for flood disasters.

The types of documents found to report the disasters that occurred were: AVADAN – Damage Assessment Report, NOPRED – Preliminary Notification of disaster, decree, ordinances, newspaper, Fide – Disaster Information Form,

and others, for other documents. The disaster with the highest number of occurrences in the system was floods, followed by floods and floods.

4.2 OCCURRENCES OF FLOODS

The flood disasters have a total of 81 documents available on s2id, totaling 96 municipal occurrences, distributed in 43 municipalities in the period from 1978 to 2013, the year of the last available occurrence.



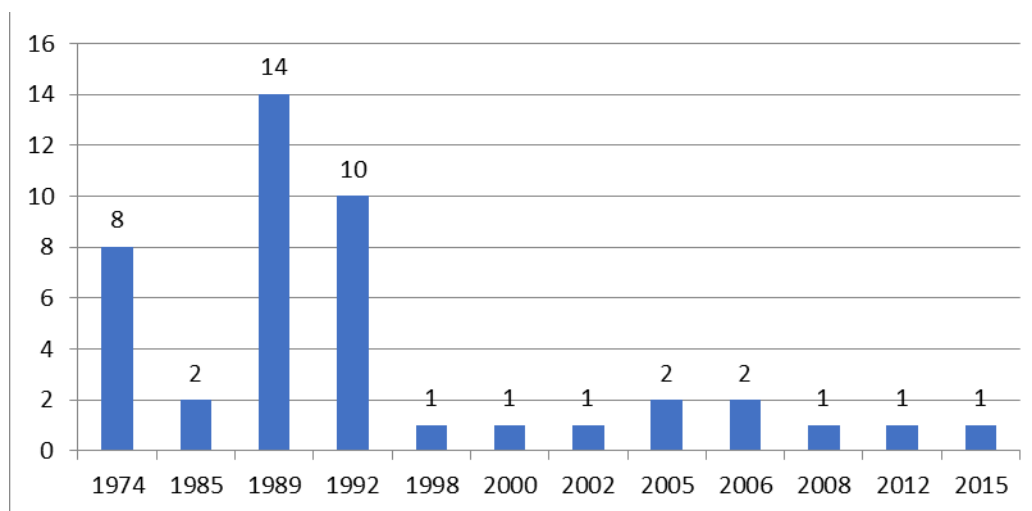
Graph.1: Number of municipalities affected by inundation.

According to graph 1, the year of the largest number of municipalities with flood disaster occurrence was 1982 with a total of 25 municipalities affected.

The municipality with the highest number of occurrences in the period from 1978 to 2013 was the municipality of São Sebastião do Tocantins, with a total of 7 occurrences.

4.3 FLOOD OCCURS

Flood disasters have a total of 49 documents available on s2id, totaling 51 municipal occurrences, distributed in 29 municipalities in the period from 1974 to 2015, the year of the last available occurrence.



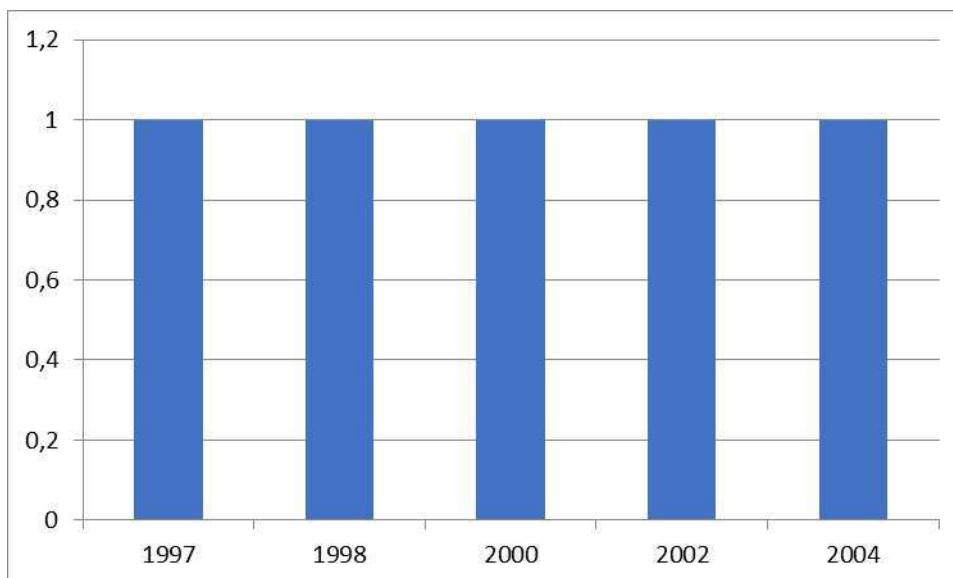
Graph.2: Number of Municipalities Affected by Floods.

According to graph 2, the year of the largest number of municipalities with flood disaster occurrence was 1989 with a total of 14 municipalities affected.

The municipalities with the highest number of occurrences in the period from 1974 to 2015 were Philadelphia and Babaçulândia, with a total of 4 occurrences each.

4.4 FLOOD OCCURS

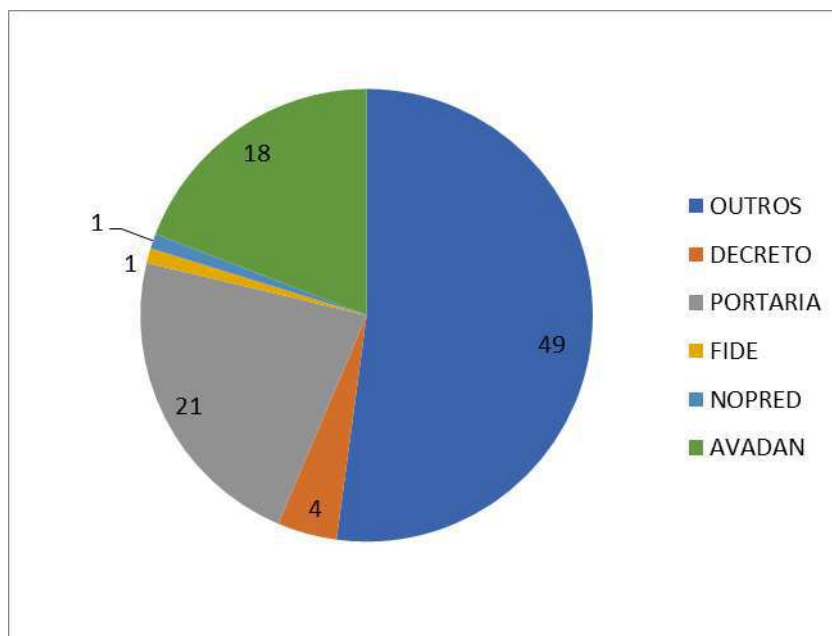
In total, only 5 flood disasters were reported, which occurred in the years: 1997, 1998, 2000, 2002 and 2004, referring respectively to the municipalities of Simolândia, Bernardo Sayão, Esperantina of the Tocantins, Carrasco Bonito Mateiros.



Graph.3: Number of Municipalities Affected by Flooding.

4.5 DOCUMENT TYPES

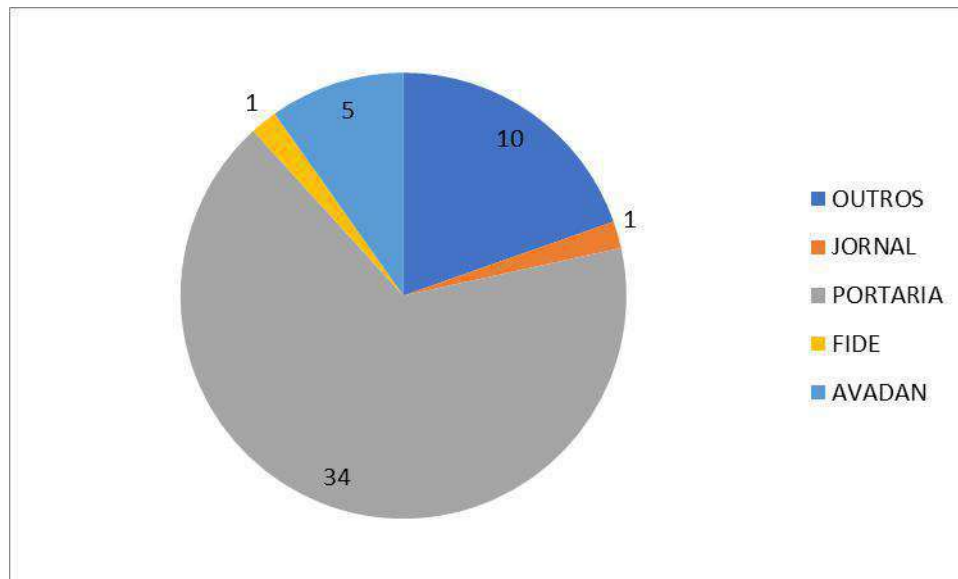
In the occurrences of Floods, from 1978 to 1997 it is possible to find documents of the type decree, ordinances and others, only from the year 2000 it is possible to have access to reports of damage assessment - AVADAN and Preliminary notification of disaster - NOPRED, and a Disaster Information Form - FIDE in 2013.



Graph.4: Documents Inudations.

Graph 4 shows the total of each document type recorded for flood occurrences in the total search period.

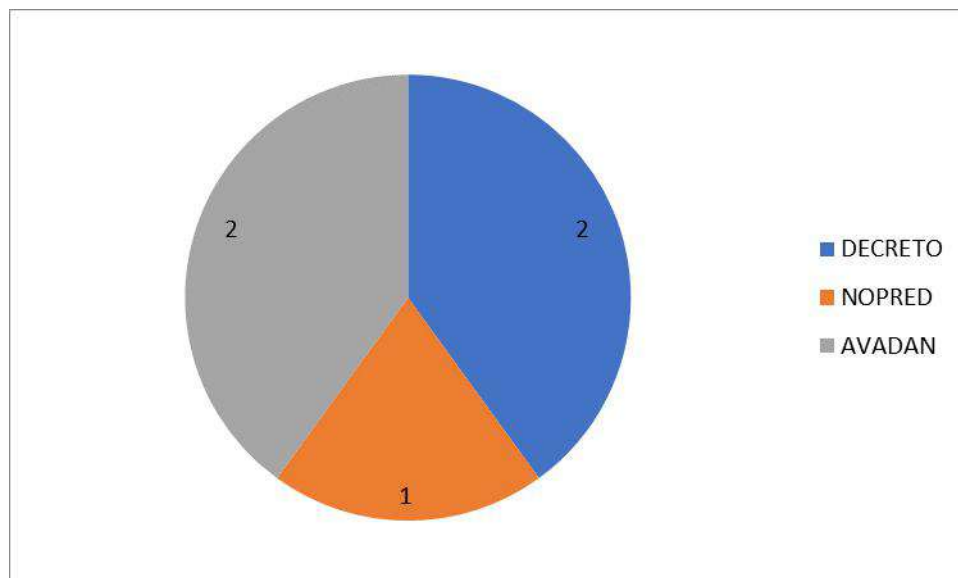
In the occurrences of floods from 1974 to 1998 it is possible to find documents of the type ordinances and others, only from the year 2000 it is possible to have access to reports of damage assessment - AVADAN and Disaster Information Form - FIDE.



Graph 5: Documents Floods.

Graph 5 shows the total of each document type recorded for flood occurrences in the total search period.

The first recorded occurrence of flooding is in 1997 by decree, and from 1998 on, damage assessment reports – AVADAN and Preliminary Disaster Notification – NOPRED are already available.



Graph. 6: Flood Documents.

Graph 6 shows the total of each document type recorded for flooding occurrences in the total search period.

Municipalities monitored via CEMADEN.

Within the scope of the National Risk Management and Disaster Response Plan, CEMADEN currently monitors 959 municipalities in all Brazilian regions that have a history of natural disaster records and risk areas for identified, mapped and georeferenced hydrological and geological processes.

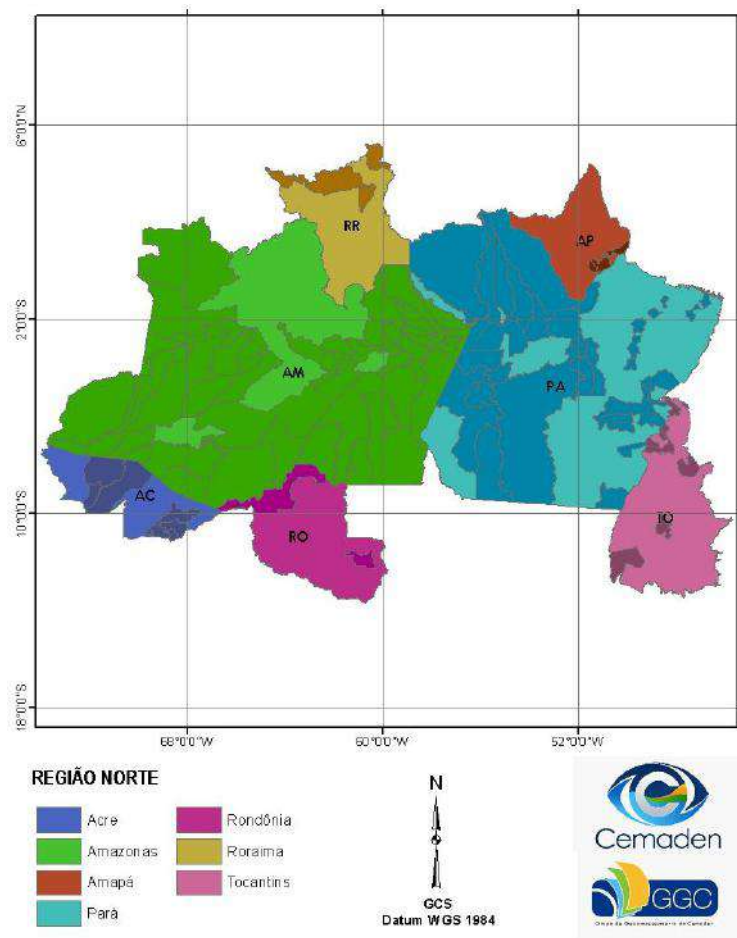


Fig.1: Monitored municipalities of the Northern Region.

Source: CEMADEN

In the state of Tocantins the monitored municipalities are Formoso do Araguaia, Goiatins, Porto Nacional, Santa Fé do Araguaia, São Miguel do Tocantins, São Sebastião do Tocantins, Xambioá, Araguañã, Araguaatins, Araguaína.

Municipality	Flood	Flood
Formoso do Araguaia	2	1
Goiatins	2	2
Porto Nacional	3	2
Santa Fé do Araguaia	0	1
São Miguel do Tocantins	3	0
São Sebastião do Tocantins	7	3
Xambioá	4	1
Araguanã	0	3
Araguatins	4	1
Araguaína	1	3

The municipalities monitored by CEMADEN have in common the fact that they are the municipalities with a high number of occurrences of disasters involving Floods and Floods in S2ID, in the period from 1974 to 2015, being listed in table 1.

V.CONCLUSION

Brazil now has consolidated bodies, which collect data related to the occurrence of natural disasters, headed by the National Secretariat for Protection and Civil Defense (SEDEC), through the National System of Protection and Civil Defense (SINPDEC), and the Tool S2ID - Integrated System of Information on Disasters.

Given the whole context, and data presented, it is possible to relate the importance of obtaining and recording historical data involving natural disasters, because evaluating the occurrences, the places where most occur and the type of disaster, it is possible to map the places of greatest risk of recurrence of the problem, as does CEMADEN - the National Center for Monitoring and Alerting Natural Disasters, thus allowing the minimization of human and material damage in cases of recurrence, allowing the prior planning of dealing with the occurrences.

In Tocantins, it is possible to relate the results obtained by the S2ID of hydrological disasters, with the municipalities with higher risks involving natural disasters in CEMADEN, due to the effectiveness of the integration process of national disaster prevention programs.

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Operations in the Cotton Chain: A Study at Agro-industrial Cooperative Holambra II and the Paulista Association of Cotton Producers (PACP)

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Keywords— Operations Management, Agro-industrial Cooperative, Cotton Chain, Cotton, Plume.

Abstract— The study aims to study the operations of the cotton chain at Agro-industrial Cooperative Holambra II, especially the operations of planting, harvesting, processing and storage and destination of by-products. Of a basic nature, with a qualitative focus and exploratory descriptive objectives, the Case Study approach was used, supported by bibliographic research. Semi-structured interviews, documentary research and structured observation were the tools used in data collection. The Cooperative implemented changes in its organizational and compliance structure, seeking to increase its efficiency in decision-making, in addition to expanding its competitive advantages with better market positioning. The 2020/21 crop showed a sharp reduction in planted area, in view of the uncertainties caused by the Covid-19 pandemic, in addition to competition from other products, with a consequent drop in production, and productivity above the average of the last five harvests. The Cooperative's strategy for anticipating the harvest period provides conditions for making the product available on the market in advance, with the possibility of obtaining higher prices. In the 2019/20 harvest, the production of plume at the Cooperative was equivalent to more than 70% of the state production. The study contributes to the expansion of the study of agricultural cooperatives in the field of management, focusing on the production of cotton, which produces the most important of textile fibers.

I. INTRODUCTION

Agribusiness has been for several years one of the main players in the Brazilian economy, with unequivocal and evident capacity for growth, as well as remarkable proof of resilience, demonstrated, above all in the most recent periods of economic instability.

In terms of world merchandise volume, there was a small decline of 0.1% in 2019 after an increase of 2.9% in the year 2018. In terms of value, world trade was down by 3.0% compared to the 10.2% increase in the year 2018 (WTO, 2020). Fact is that all global regions recorded a

decline in merchandise trade in terms of volume and value in the year 2019.

Probably, the COVID-19 pandemic will cause a significant contraction in world trade in 2020. Preliminary indicators already point to sharp falls in the first and part of the second half of 2020. For the first time since the 2008-2009 crisis, the volume of world trade in goods has plummeted in the first half of 2020, under pressure from rising trade tensions, especially between the United States and China, and weakening economic growth, particularly due to COVID-19.

The International Monetary Fund (IMF) forecast for 2020 predicted that after China, the countries that would show the highest growth rate would be those of Latin America and the Caribbean, surpassing even the United States and the average of the European countries. The worsening of the economic scenario led to the opposite situation. The countries that suffered most from the implementation of policies of isolation and social distancing were the countries of Latin America and the Caribbean.

Brazil is the fifth-largest producer and fourth-largest exporter of cotton in the world, behind the United States, Australia and India (Abrapa, 2017). New agricultural management techniques, investment in research and development (R&D) and improved processing have contributed to increasing the quality and quantity of Brazilian cotton, adapting it to the needs of the industries.

In Brazil, cotton (*Gossypium hirsutum* L.), considered one of the most important industrial crops in the world (Farias et al., 2016), has been growing steadily over the years, becoming the second-largest exporter of lint worldwide. With the crisis caused by the Covid-19 pandemic, demand, both internal and external, has suffered a negative impact. In this scenario, the projections are for reduction in the area and production for the 2020/21 cotton crop. However, the specificities of the production system (highly technical production structure, including machinery and workforce), the investments already made, as well as the high percentage of future marketing, discourage producers from reducing the area.

The Brazilian cotton lint crop of 2020/21 is estimated at 2.59 million tons, down 11.7% compared with the 2.93 million tons indicated in the 2019/20 crop. The productivity of crops is estimated at 1,746 kilograms of cotton lint per hectare, compared with 1,753 kg/ha in the 2019/20 crop. According to the econometric model of forecast scenarios, the area planted with cotton in the 2020/21 season is estimated at 1,495 million hectares, down 10.5% compared with 1.67 million hectares of the previous crop (Conab, 2020).

Cotton is delimited in the concept of natural fiber (Akil et al., 2011; Pujer et al., 2014), being the main raw material (plant fiber) employed in the textile sector. According to its origin, natural fibers can be divided into animal and mineral, in addition to plant fibers, with their own characteristics and properties (Sanjay et al., 2018). The uses and applications of seed cotton and its derivatives were described and analyzed in a study conducted by Desrochers & Szurmak (2017).

For what is intended in this study, the processes that involve planting, harvesting, as well as all the handling of

cotton until the processing plant are essential in the commercial quality achieved by the final product intended for the textile industry.

The research aims to study the operations of the cotton chain at Agro-industrial Cooperative Holambra II, especially planting, harvesting, processing and storage of the lint and destination of by-products.

From the amount of studies found in the literature, there is a belief that cooperatives have attracted little interest in the field of management science, being largely neglected within economics and management theory (Mazzarol et al., 2011; Jussila et al., 2012; Puusa et al., 2013; Puusa et al., 2016). Thus, a primary contribution of this article can be seen as the insertion of the study of cooperatives in the field of management research, especially agricultural producer cooperatives (Hernández-Espallardo, Arcas-Lario, & Marcos-Matás, 2013; Verhees, Sergaki, & Van Dijk, 2015), focusing on the production of cotton, which, according to Embrapa (2005) produces the most important textile fibers, natural or artificial, since it is able to offer a wide range of products with great relevance in the national and world economy, which is why it is considered one of the most fully exploited plants.

The structure of the article is established from this section, where the introduction and the objective of the study are located. Section 2 was reserved for the literature review, followed by the methodology (section 3). Section 4 was designated for data presentation and discussion, followed by the conclusion (section 5).

II. LITERATURE REVIEW

2.1 Cotoniculture Production

The shift of the cotton production hub to the Mid-West enabled the expansion of the cultivated area and the transition from an obsolete production model, characterized by low productivity, to a corporate production model with better performance. Consequently, the commodity's production grew, which, concomitant with the reduction in domestic consumption, led to an increase in exports, made possible by the quality of the Brazilian product (Alves et al., 2021).

Data from the National Supply Company (CONAB) show a 14.5% reduction in the planted area when comparing the 2019/20 and 2020/21 harvests, registering a rupture in the expansion that had been occurring since the 2014/15 harvest. The reduction was the result of the market downturn that occurred during the Covid-19 pandemic, which caused the paralysis of sales, renegotiation and cancellation of signed contracts, and an increase in global transit stocks, causing lower sales of the

crop to be planted, when compared to the previous crop (Conab, 2021). Production and productivity also fell by 16% and 2.3%, respectively, compared with the previous cycle (2019/20).

The state of São Paulo showed a significant reduction of 57% in the planted area compared with the previous crop, going from 11,000 hectares cultivated in the 2019/20 crop and plume production of 17,200 tons, to 4,700 hectares in the 2020/21 crop and production of 7,400 tons. Many of the traditional producers in the Avaré region have opted to plant soybean instead of cotton, taking advantage of the moment of attractive prices that soybean has presented.

The cultivation of cotton - harvested as seed cotton, it needs to go through a processing process in order to separate the seed from the fiber (Coleman & Thigpen, 1991; Bajpai, Mary, & Chand, 2015) - results in products with diversified industrial application, with a high rate of utilization of the plant (Abrapa, 2013; Desrochers & Szurmak, 2017).

The application of cotton occurs in two main segments: the textile that absorbs the lint, which in economic terms is the main primary cotton product (Amaral et al., 2018), which can represent up to 40% of the fruit, and the non-textile that uses the seed in the production of oil and derivatives, feed production (Li & Robinson, 2011; Świątkiewicz, Arczewska-Włosek, & Józefiak, 2016), the fibril, used in the automotive industry (Kamath, Bhat, Parikh, & Mueller, 2005; Dunne, Desai, Sadiku, & Jayaramudu, 2016) and other waste (Ouslimani & Bouregghda, 2018).

The cotton chain is characterized by, among other things, the intensive use of technology (Conab, 2018) and the high capacity to add value (Abrapa, 2017). Technologies such as the No-till System (SPD) have been adopted since the 1970s in Brazil, where more than 32 million hectares of land are under this system (Peixoto et al., 2019). SPD is characterized by non-involvement, permanent soil cover and crop rotation, increasing the sustainability of ecosystems (Salton, Hernani & Fontes, 1998). Phillips et al. (1980) define SPD as one in which the crop is planted entirely without soil preparation or only with sufficient preparation to allow seed placement and coverage with soil to allow it to germinate and emerge.

The technology of reducing the spacing between the rows of cotton - adensed method (Narrow Row cotton - NRC), is a technique of North American origin that allows reducing the crop cycle (Rosolem et al., 2012; Kazama et al., 2016), allowing the minimization of phytosanitary applications, with consequent reduction of production cost, being, in many cases more advantageous in relation to the

conventional cropping system (Conventional Row) - spacing between 0.76 to 102 cm (Constable, 1977; Clawson et al., 2008). Empirical studies have demonstrated the reduction in costs resulting from the adoption of the adensed planting system in comparison with the conventional system (Jost & Cothren, 2001), above all because of the lower use of phytosanitary products.

Cotton has a high production cost, about three times that of soybeans (Brandão, Zonta & Ferreira, 2014). The need for high application of external inputs (fertilizers and synthetic pesticides), in addition to the need to maintain the levels of sufficiency in the soil (Rosolem & Mellis, 2010) increase production costs and directly affect the profitability of the crop; these inputs can reach 65% of the total cost of production (Cepea, 2020).

Currently, cotton harvesting is mostly mechanical, performed with self-propelled harvesters. The fiber, which has its quality (Boykin & Reddy, 2010) determined by its color (Barker, Baker, & Laird, 1990), is the main raw material of the textile industry. The economic value of cotton is directly related to the harvest process, taking into account factors such as the contamination of cotton with other fragments of the plant and other impurities, excess moisture that can cause fermentation, early fibers, strength, length and color of the fiber. According to Embrapa (2005), care in harvesting, packaging and transportation are responsible for the quality of cotton, since excess impurities imply additional expenses with transportation and problems in processing and obtaining low-quality fiber.

The cotton mechanical harvesting process can be carried out by the cotton picker that operates based on manual harvesting, and the machine is equipped with rotating spindles; and the cotton stripper, equipped with a pulley system that harvests open or semi-open stalks and fruits. In this type of machine, the harvested cotton contains a higher quantity of impurities, increasing transportation costs per bale, besides the higher costs of cotton processing. Even using an HL extractor, the levels of matter will still be higher than those found in picker-type harvesters (Faulkner, Wanjura, Shaw & Hequet, 2007).

The stripper-type harvesters have lower acquisition prices, fewer moving parts in the row units, lower fuel consumption and maintenance. The picker-type harvesters, although with higher acquisition prices, harvest cotton with less impurity, increasing the capacity to preserve the characteristics of fiber quality, besides being able to harvest cotton at higher speeds in places with high productivity (Faulkner et al., 2007).

Fiber quality is assessed by visual classification and laboratory analysis using the High-Volume Instrument (HVI) and other complementary instruments (Sayeed, Schumann, & Wanjura, 2021). Through the HVI, fiber characteristics such as Strength (STR), Length (UHML), Micronaire (Fiber fineness), SFI (Short Fiber Index), Elongation (ELG), Maturity (MR), RD (Reflectance/Brightness/Grayness), +B (Yellowing degree), Thash Sheet (Impurity degree) are analyzed. A set of procedures will be indispensable for determining the economic value and the appropriate types of use of the fiber, especially by the textile industry.

2.2 Agro-industrial Cooperatives as Forms of Collective Action

Firms are creating organizational models based on complementarity, collectivity and through relationships and interdependence ties between the most diverse actors, which is considered fundamental for agri-food economies (Hardin, 1997; Ménard & Klein, 2004).

Cooperatives in general and agro-industrial cooperatives in particular are configured as forms of collective action (Ménard & Klein, 2004; Zylbersztajn, 2005). The governance structures of this type of collective action (cooperatives) are able to enable advantages such as increased revenues, cost reduction through economies of scale, reduced transaction costs, greater bargaining power, risk minimization, increased bargaining power, in addition to collective learning and positive externalities (Lazzarini et al., 2001). These agricultural associations are capable of appropriating the coordination of complex agri-food systems. This know-how, as a rule, follows the verticalization trend of cooperative structures. Corroborating with Sexton (1986), understanding cooperatives means understanding the incentives for vertical integration as a value appropriation strategy.

It was believed that the industrialization of agriculture would bring about the end of farmers' cooperatives (Helmberger, 1964). In response to this prediction, Abrahamsen (1966) contested by advocating that as the industrialization of agriculture evolved, cooperatives would increasingly become the "integrating agency of the farmer".

Cooperative can be defined as an association with its own autonomy, consisting of people who seek to satisfy their common economic, social and cultural needs and aspirations through a jointly owned and democratically controlled enterprise (ICA, 2017). Agricultural cooperatives are able to provide economic benefits to farmers through sharing and pooling of resources, better access to markets, higher yields for their products and

strengthening in bargaining position, improving members' livelihoods and local reinvestment, and supporting rural development (Sergaki et al., 2020). Through production contracts, granting of delivery rights and delivery obligations, all business functions can be streamlined. Nevertheless, cooperatives are important competitors in many industries (Hendrikse, 1998), agribusiness being one of them.

2.3 The Agro-industrial Cooperative Holambra II

The Cooperative Agro-industrial Holambra II is headquartered at Rodovia Raposo Tavares, km 256, in the municipality of Paranapanema – SP, founded on 23 December 1960, operating for over 60 years, with an area of operation in the national territory, operating in agricultural and extractive production with approximately 62,000 hectares of production area. In 2018, the Cooperative was ranked by Exame magazine among the 400 largest in the agribusiness segment and among the 1,000 largest companies in net sales.

The Cooperative developed within the traditional patterns until the year 1988. However, the indispensability of improving its efficiency in a competitive environment directed its board of directors to conduct a process of operational structure reduction (the structure of operations had 5 departments that reported to a general manager who, in turn, answered to the Council) and, consequently, more agility and flexibility (Zylbersztajn, 1994).

The changes that took place in the Brazilian political-economic environment, especially in the 1980s and 1990s, pressured the cooperatives to adjust with a view to expanding or at least maintaining their market share. In this sense, although the Cooperative does not configure a vertical integration in all its amplitude, it is consistent with the postulated by Sexton (1986) for whom the reduction of costs through better bargaining power in the acquisition of inputs; the economies of scale, the improvement of the bargaining position in the market, the efficiency gains from the coordinating capacity and the reduction of risks in joint actions are common factors to this type of enterprise, even though this is not the predominant pattern, since most cooperatives do not have appropriate structures to correspond to the qualification, diversification and flexibility requirements that the current conjuncture demands. Figure 1 presents the institution's organization chart according to the information on its website.

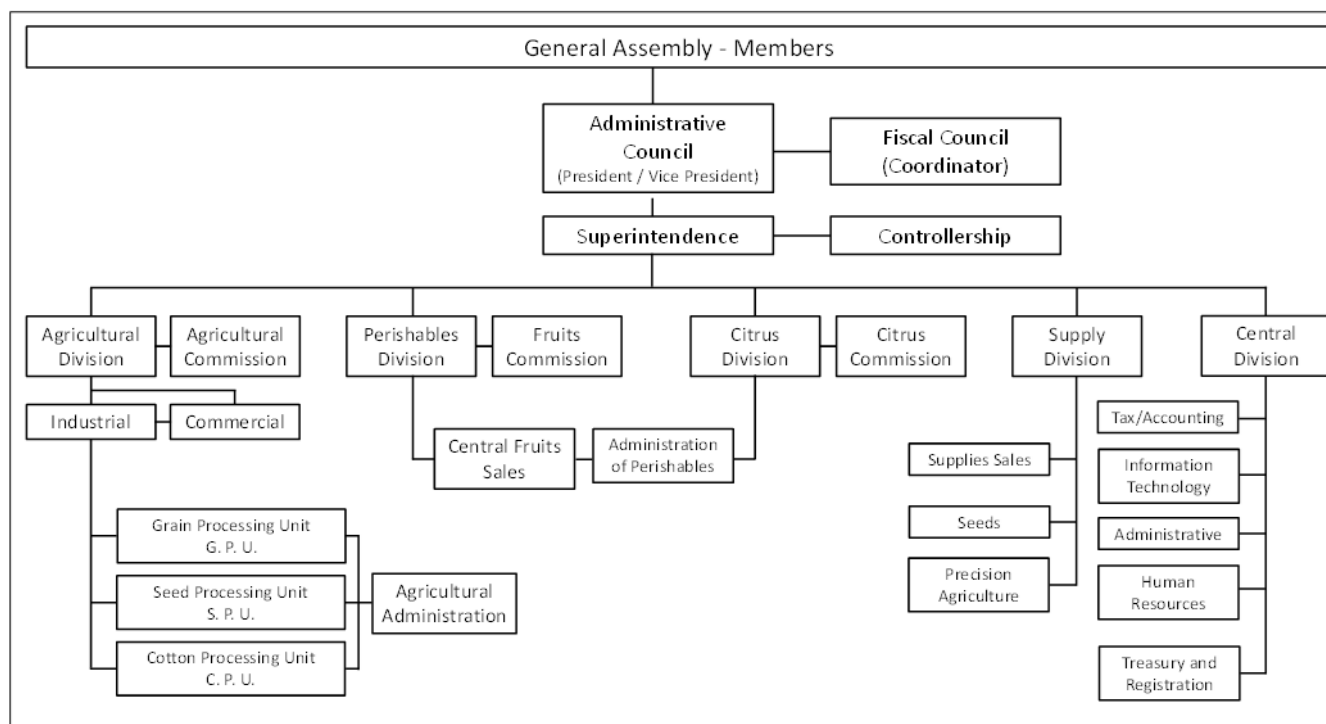


Fig.1: Holambra II Cooperative's organizational chart as shown on the institutional website

Source: Adapted from Holambra II Cooperative's Institutional Website. Available at:

<https://www.holambra.com.br/cont.php?p=organograma>. Accessed on April 14, 2020.

It is understood that this configuration represented an increase in managerial flexibility and improvement in the capacity to control the results in each Cooperative business, with a focus on increasing efficiency in the decision-making process (Alves, Ferreira, & Araújo, 2019; Fedorova & Valiev, 2021). Zylbersztajn (1994) adds that the producer-cooperative was stimulated to increase his participation in the strategic decision-making process and his interest in controlling the managers of the units in which he has investments. His income became associated with the results of the business unit that centralized his investments.

This is what we know up to the moment we collected information from the documents available on the Cooperative's institutional page.

III. MATERIALS AND METHODS

Of a basic nature, the method adopted in this study proceeds a qualitative approach with exploratory descriptive objectives. Given the need for a holistic view of the process, in addition to the need to accommodate a variety of data sources (Eisenhardt & Graebner, 2007), we opted for the Case Study approach (Benbasat et al., 1987; Meredith, 1998; Orum, Feagin, & Sjöberg, 1991), as understood by Hartley (1994), Gummesson (1988), Eisenhardt (1989), Yin (1993) and Stake (2000).

The bibliographic research was adopted as a research strategy, considering it as a research subsidy (Boote & Beile, 2005). The empirical field of analysis was the field operations (planting and harvesting) and the internal operations (processing and storage of the lint and other byproducts) in the Agro-industrial Cooperative Holambra II, referring to the 2020/21 crop. The interviews were carried out in April 2021 (start of the harvest), by means of a semi-structured script, with the Executive Director of the Paulista Association of Cotton Producers (APPA), the Commercial Manager of Agricultural Commodities, besides the Supervisor of the Cotton Beneficiation Unit (plant), both from Holambra II Cooperative, corroborated by the implementation of structured and non-participant observation, whose methodological artifacts were circumscribed in the case study protocol, previously prepared. To complement the information, a second interview was scheduled with the Commercial Manager and Commercial Coordinator (Trade) through the Microsoft Teams platform in May 2021 with a 60-minute duration. The documentary research was used as a way to gather financial data, production data, organizational charts, among other physical components that contributed to the research. To better understand the phenomenon, we adopted the perceptual triangulation as proposed by Bonoma (1985) in order to ensure the accuracy of the evidence.

IV. RESULTS AND DISCUSSION

Cooperative Holambra II, a direct consequence of a collective action (Ménard & Klein, 2004; Zylbersztajn, 2005), has 159 cooperative members, 523 employees, and presented in 2020 a turnover of 1.3 billion reais. In the words of the president of the Board of Directors *"in a short time the market not only recovered, but began to react positively, with excellent prices for soybeans, corn, cotton, wheat and even fruit, in a year with excellent productivity!"*

This, coupled with other factors, contributed a lot to build the expressive result of the Cooperative in 2020".

In mid-2020, the Cooperative implemented changes in its organizational structure and governance, aiming at long-term sustainable growth, efficiency gains in the decision-making process (Alves, Ferreira, & Araújo, 2019; Fedorova & Valiev, 2021), and enhancement of the corporation's competitive advantages (Lazzarini et al., 2001). Figure 2 presents the current corporate structure of Cooperative Holambra II.

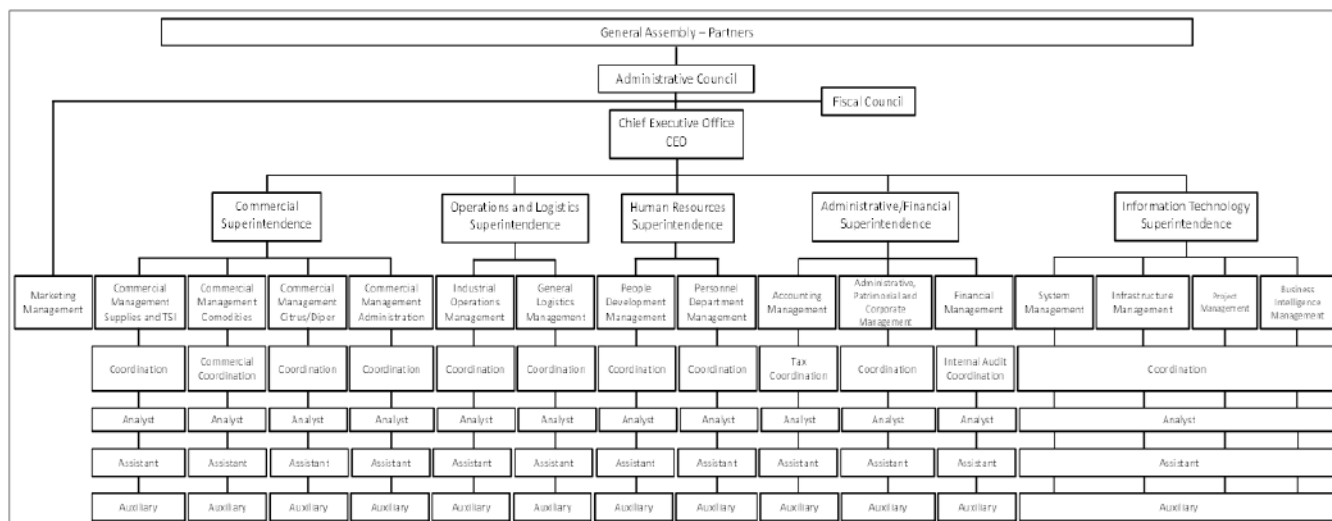


Fig.2: Holambra II Cooperative's current organizational structure

Approximately half of the cooperative members plant cotton, with this number varying from harvest to harvest. In the 2020/21 crop year, 1,100 ha of cotton were planted, an 80% reduction when compared to the previous crop year, and even more expressive in relation to the national and state scenarios (Conab, 2021). According to the Cooperative's commercial manager, *"in March 2020, at the beginning of the pandemic here in Brazil, there was a lot of uncertainty, and the producer decided not to plant cotton... besides, soy was very favorable with high gains"*. Table 1 presents the number of farms, planted area production and productivity for the cooperative producers for the last five harvests.

Table 1: No. of farms, planted area, production and productivity for crop years 2016/17 to 2020/21

Crop-Years	Nº of Farms	Planted Area (ha)	Plume Production (ton.)	Productivity (kg/ha)
2016/17	15	1.155	2.287	1.980
2017/18	39	4.446	8.803	1.980
2018/19	64	7.995	16.789	2.100

2019/20	44	5.380	12.266	2.280
2020/21	11	1.100	2.442	2.220

Agricultural planning and the execution of crop treatments are the exclusive responsibility of the cooperative producer (Hardin, 1997; Ménard & Klein, 2004). The Cooperative purchases all the inputs that will be used by the producers, achieving a differentiated price in relation to the quantity purchased, allowing producers to purchase the inputs directly from the Cooperative with a more competitive price (Abrahamsen, 1966; Sergaki et al., 2020). Therefore, all the cooperative members' production is purchased by the Cooperative, which will market it in the domestic and foreign markets. In the case of cotton, in particular, the byproducts arising from the processing process (seed, fiber, waste, in addition to the polyethylene film already used) are also marketed to third parties, according to uses and applications proposed by Desrochers and Szurmak (2017). Nevertheless, the Cooperative's customary performance finds support in Hendrikse's (1998) proposal. Figure 3 illustrates the dynamics of the

relationship between the Cooperative, the members, the processing unit, and the buyer market.

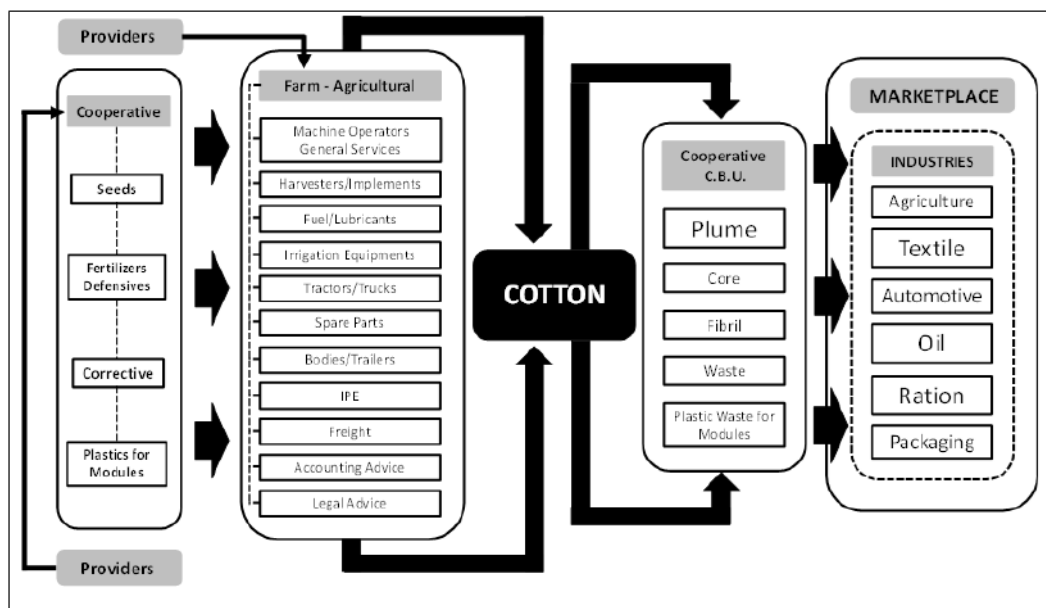


Fig.3: Outline of the relationship between the Cooperative, producers, processing unit, and buyer market

APPA, whose headquarters are in the Campos de Holambra district, acts as a strategic partner of the Cooperative, besides participating in the "agricultural" and "UBA" stages of cotton.

According to APPA's Executive Director, "we are partners, we exchange several information (planting area, quotations, quantities of seeds bought, etc.). Indirectly, we encourage the increase of the cotton area to be planted in the region and help the cooperative economically...". Figure 4 illustrates APPA's performance in the agricultural and cotton processing stages.

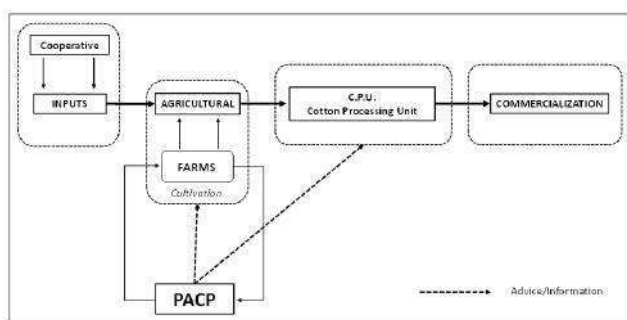


Fig.4: APPA's activities in the various stages of cotton production

Especially in the Agricultural area, the Association offers monitoring of cotton growers by means of traps. Armed with this information, producers can make better decisions in combating the pest, obtaining better productivity, quality and, consequently, profitability. APPA traditionally promotes Field Days, Meetings, crop

tours, actively participates in GTA meetings, and frequently hires consultants from other regions to advise on the implementation of improvements in the management conducts, improving the productivity, quality and profitability of the plume.

APPA has 80 members distributed in 13 municipalities with cotton planting areas. In the last 5 harvests (2016/17 - 2020/21), in descending order in hectares planted are the municipalities of Itai, Itapeva, Riolândia, Rancharia, Martinópolis, Cardoso, Paranapanema, Taquarituba, Angatuba, Paulo de Faria, Pirassununga, Mogi Guaçu and Guará.

The planting system adopted in the farms is SPD, possibly inserted in the area volume cited by Peixoto et al. (2019), whose understanding is anchored in the molds proposed by Phillips et al. (1980), presenting the gains gauged by Salton, Hernani and Fontes (1998). Cotton planting in the research region is done in the conventional system (Clawson et al., 2008) to the detriment of the adensed system as discussed in Rosolem et al. (2012) and Kazama et al. (2016). According to the APPA executive, "our region is very humid, so if it is adensed, it is much more prone to diseases. And, if it is adensed, it gives us less productivity". Given the climatic conditions of the region, the conventional method is the most appropriate, otherwise (Jost & Cothren, 2001), there will be increased cost, decreased productivity and loss of profitability, especially due to the need for greater use of inputs (Rosolem & Mellis, 2010).

In the last harvest (2019/20), cooperative members produced 12,150 tons of plume - equivalent to more than 70% of the state production. Inputs accounted for 64.29% of production costs, within the parameters identified in the literature (Cepea, 2020), followed by farming, with 19.28% and processing with 16.43%. The standard period of the cotton harvest in Brazil varies by region, in general the planting is between the months of December/January and the harvest May/June/July. In Holambra *"the harvest is between October and April, therefore, two months in advance"*, says the Executive Director. The anticipation strategy provides the Cooperative the advantage of making the product available in advance in the market, with the possibility of reaching higher prices.

Data from the field stage show the mechanized harvest (Embrapa, 2005), using a John Deere 7760 harvester with 537 hp and gross weight of 30,700 kg (Fig. 5a), capable of harvesting, storing, pressing, baling, and wrapping the fibers in a polyethylene film that protects the seed cotton (Fig. 5b), and can weigh up to 2,500 kg. The cylindrical roller baling technology allows the harvester to perform a continuous harvest without interruptions for unloading the harvested cotton.



Fig.5: Self-propelled picker and the cotton drum wrapped in polyethylene film

The quantitative losses in the harvest are around 8 and 10% of cotton, as recorded by the structured observation and corroborated by the interview with the executive director who states that it is *"standard [...] these eight or ten percent stay right in the crop"*. He complements that *"if the producer chooses to pass the bale harvester after having passed the roller harvester, the bale harvester will get there another eight or seven percent and ends up getting there two or three percent still in the field, but it is standard, yes ..."*. In this case, the producer uses a John Deere harvester mod. 3350, without a baling system, to harvest this cotton. When its reservoir is complete, the harvester unloads this cotton into a press (Bass Boy - Buza - mod. EB-11T) that stays in the field and, after compacted, the bales weighing 11,000 kg are transported to the processing plant. Notably, this is only feasible because the producer in which the field research was conducted, already has the machine and the operator full time on the farm. Figure 6 shows the harvester model used

for the residual harvesting (a), as well as the unloading into the Bass Boy press (b).



Fig.6: John Deere 9935 e Bass Boy press - Buza mod. EB-11T

Considering the load capacity and harvesting speed of the John Deere 9935 machine, it is estimated that the press can take up to a full day's work to be filled and in the pressing stage, when the bale will have a weight of 11 tons.

The rolls and bales are collected the same day, being brought from the field to the yard of the processing plant (Coleman & Thigpen, 1991). According to the words of the supervisor of the UBA, *"the first step in the processing of cotton in the mill, is the placement of the roll in the 'piranha', belt or bale cutter,"* where the plastic is removed and separated (Figure 7-a). The cotton goes on the conveyor belt for decompacting (b), at which time the first measurement of the cotton's humidity is taken, which *"must be between 6.5 and 7.0"* (c); the next step is the pre-drying process and concomitant pre-cleaning of the seed cotton, separating the larger impurities (husks, leaves, and small wood chips).



Fig.7: Roll inlet on conveyor, conveyor and moisture measurement

Through suction ducts, the cotton proceeds to the gin, which mechanically separates the fiber from the seed, turning it into ginned cotton (Figure 8-a), according to Bajpai, Mary and Chand (2015). The seed is sold as a by-product (Li & Robinson, 2011; Świątkiewicz, Arczewska-Włosek, & Józefiak, 2016); the plume (b), follows by pipelines to another cleaning stage. The impurities of the plume, the fibril, is separated and transported by suction to the press (c), where it is pressed and subsequently sold as a by-product, especially to the automotive industry (Kamath, Bhat, & Mueller, 2005; Ouslimani & Bouregghda, 2018).



Fig.8: Ginning, lint cleaning and fibril pressing

The fiber (plume) in its final stage goes to the pressing operation (Figure 9-a), where it is compacted into bales with an average weight of 200 kg (b) in a time of 1min20sec to 1min30sec, and stored in sheds (c). Before packing the pressed bale, two fiber samples are taken, one being taken for visual classification (C.V. - right label, Figure 9-b), where a quality code will be assigned (Boykin & Reddy, 2010), as a first step in the product value scaling (Barker, Baker, & Laird, 1990), and the other will follow for laboratory analysis in a laboratory outsourced by the Cooperative.



Fig.9: Smart Box 45 press, bale labeling and transport to storage

The coded result of the laboratory analysis is later reported on the bale label with the acronym HVI (High Volume Instrument - equipment used to measure the intrinsic characteristics of cotton fiber), according to Sayeed, Schumann and Wanjura (2021). This result will be fundamental in the lint valuation process, as well as in the correct use by the textile industry, being destined for both domestic and foreign markets.

V. CONCLUSION

The study aimed to study the operations of the cotton chain at Agro-industrial Cooperative Holambra II, especially the planting, harvest, processing and storage of the lint and other byproducts.

The Cooperative has implemented changes in its organizational structure and compliance, seeking to increase its efficiency in decision-making, besides expanding its competitive advantages with better market positioning. The 2020/21 crop showed a strong reduction in the planted area, due to the uncertainties caused by the

Covid-19 pandemic, with a consequent drop in production. Although productivity was a little lower than last year's, it remained above the average of the last five harvests.

The organization has a strong position in the commodities market, serving the internal and external markets. APPA acts in partnership with the Cooperative and the producers in the search for the best market positioning.

Primarily, the article contributes to the expansion of the study of agricultural cooperatives in the field of management, focusing on the production of cotton, which produces the most important textile fiber. Although the field operations were circumscribed to a single producer, the information collected can be safely generalized to the cooperative producers, since they are standardized operations, except for the specificities mentioned.

The conclusion of the study allows the proposition of a future research agenda that undertakes efforts to better understand the implications of structural changes in the organizational context.

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Blockchain: The Key Success of Healthcare Development

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Abstract— Blockchain is a technology for storing and managing sensitive data such as financial information, health records, and transactions. It is a decentralised, distributed public ledger that is maintained by the network of a verified group of individuals or nodes. All nodes need to reach an agreement on whether the data should be kept in the block to guarantee that the data are safe and no corrupt branches. Healthcare is one of the potential fields where blockchain technology can be implemented, especially with the respect to health management. This brings an advantage to healthcare firms because currently patients' data are stored by third parties. This technology allows more security in the data management process and prevents the misuse of data. One of the greatest benefits of using blockchain in healthcare management is that records are stored in a distributed database due to the feature of decentralisation. Data in this system is always kept up to date and records are kept by timestamp. Interestingly, blockchain can be integrated with other advanced technologies such as artificial intelligence (AI) to generate predictive analytics models for patients' treatment and diagnosis

I. INTRODUCTION

Healthcare has been experiencing privacy and security breaches of healthcare's data every year from centralised networks. Also, communication within healthcare has caused many issues in time management, the effectiveness of healthcare and slow development of future goals, etc. Therefore, the increase in technology implemented in healthcare has led to the acknowledgment of concerns about ownership, interoperability, secured storage, and communication (Talesh, 2017; McCoy & Perlis, 2018; Meinert et al., 2019).

Blockchain technology is one of the advanced technologies that brings a solution to healthcare. Blockchain emerged from digital currencies called cryptocurrencies (Swan, 2015; Agbo et al., 2019) which can be viewed as a technology for storing and managing decentralised data maintained by the network of a verified group of individuals or nodes (Jaoude&Saade, 2019).

II. BLOCKCHAIN TECHNOLOGY

Blockchain is a technology for storing and managing sensitive data such as financial information, health records, and transactions. It is a decentralised, distributed public account that is organised by the network of a verified group of individuals or nodes (Jaoude & Saade, 2019). All nodes need to reach an agreement on whether the data should be kept in the block to guarantee that the data are safe and no corrupt branches (Vukolić, 2015; Christidis and Devetsikiotis, 2016), this is called consensus. There are different Consensus Mechanisms (Mingxiao et al., 2017) such as Proof-of-Work (PoW) which is the most popular. PoW requires computational power from the miners to solve the cryptographic algorithm similar to finding hashes with specific patterns (Antonopoulos, 2014). On the contrary, there is another mechanism called Proof-of-Stake (PoS). PoS separates stake blocks equally to each miner depending on their wealth (Pilkington, 2016). This is the improved version of PoW that the data

will be more secure as if a fraud transaction is validated the miner will lose the money that they staked in the blockchain. Moreover, there is an alternative Consensus Mechanism for PoW and PoS called Proof-of-Space. This algorithm uses the free space in the disk and reduces the use of computational power. The blockchain stores the data in a block that is immutable (Höbl et al., 2018), the data are protected and bound to each other in cryptographic principle (Mendling et al., 2018).

The blockchain network is grouped into several categories (Buterin, 2015; Zheng et al., 2016; Eris Industries, 2016; Christidis and Devetsikiotis, 2016; Kravchenko, 2016; Wood, 2016) according to the network's management and permissions as public, private or federated. It is permissionless in the public blockchain which everyone can be a user or a node miner and can do any operation. The public and federated blockchain are permissions that allow only a list of users that are granted access to the network operation.

Blockchain technology was originally used in digital currencies also known as cryptocurrencies then in the application of smart contracts of the financial domain (Swan, 2015; Agbo et al., 2019). Subsequently, the blockchain evolved and focused on the government, healthcare (Swan, 2015; Miao & Yang, 2018), and culture (Efanov & Roschin, 2018) which are the non-financial areas. Furthermore, this technology is also used in the incorporation of artificial intelligence (Angelis & da Silva, 2019).

III. KEY CHARACTERISTICS OF BLOCKCHAIN

First, there are various types of blockchain that are classified by their accessibility and management system. There are three main types of blockchain which comprise public blockchain, consortium blockchain, and private blockchain (Peters and Panayi, 2016). In the public blockchain, every individual has permission to be involved in the validation process. This means that the public has the permission to access the information of the block and it is also fully immutable as information cannot be altered (Zheng et al. 2017). For the consortium blockchain, this type of blockchain refers to partial permission as only a selected group of people will be able to get involved in the consensus process as the permission to access is restricted. Unlike the public blockchain, this enables information inside the block to be manipulated (Lin and Liao, 2017). Likewise, the validation process in the private blockchain belongs to an organisation or an individual. The permission to access is restricted to some individuals only and information inside the block can be altered (Gervais et

al., 2016). These properties are essential depending on the implication for certain scenarios (Lin and Liao, 2017).

Secondly, there are various characteristics of blockchain. One of the key features of blockchain is decentralisation. In other words, all data are controlled by a distributed network rather than individuals like the centralised system (Zheng et al., 2017). For instance, in the conventional system, every transaction made by each individual must pass through a banking agency which is considered as a third party. However, if blockchain is introduced into this scenario, third parties will be eliminated from this process as blockchain are decentralised. To put it simply, decentralised systems provide access to resources in a more equitable service (Höbl et al., 2018). To a certain extent, every user has their own private key in order to make each transaction, so the information inside the network is kept confidential (Johnson, 2001). Furthermore, blockchain can also be centralised. This applies with the private blockchain where consensus belongs to one organisation or an individual; as a result, permission is needed for this type of blockchain (Zheng et al., 2017). Currently, there is a large amount of research focusing on the development of blockchain with respect to its decentralised characteristics (Conoscenti et al., 2016; Christidis and Devetsikiotis, 2016), particularly in the field of managing big data and data-intensive applications (Yang et al., 2019).

Moreover, another important characteristic of blockchain is immutability. This is also known as transparency or persistency. Before information can be stored inside the block, it must undergo a validation process once information is stored (Zheng et al., 2017). The information cannot be changed or altered (Yli-Huumo et al., 2016; Swan, 2015a). For example, transactions can be validated and stored in a block. Due to the unchangeable feature of blockchain, it is impossible to delete or change the transaction details inside the block. As a result, errors or corrupted transactions can be detected easily (Zheng et al., 2017). This leads to the validation mechanism which is known as the consensus mechanism. These algorithms help to preserve and maintain information using cryptographic signatures (Mendling et al., 2018). This mechanism also enables data records to be safely exchanged or updated by the individual in charge of this process (Alla et al., 2018). Currently, there are many new methods being developed and applied to blockchain in order to make the validation process as efficient as possible (Nguyen and Kim, 2018). Furthermore, cryptographic hashing also ensures that information cannot be altered as every block is connected in chronological order. If one block is changed or altered, every subsequent hash value of the chain will also be affected. Hence, the

whole complete chain will be disabled (Nakamoto, 2008; Gervais et al., 2016).

Lastly, every process that occurs in the blockchain gets chronologically timestamped, including generating new blocks and storing data (Nakamoto, 2008; Matilla, 2016). This feature leads to the traceability of the data inside the block that are permanently recorded. In the case of a transaction, full details and history of the transaction can be provided to the decentralised network (Zheng et al., 2018). These features can also be combined with cryptographic hashing in a process called “Proof of Existence.” The information inside the block can be proved by using this method as it provides the information at a specific time (Gipp et al, 2015).

IV. APPLICATION OF BLOCKCHAIN IN HEALTHCARE

Healthcare is one of the potential fields where blockchain technology can be implemented (Cios et al., 2019; Kuo et al., 2017), especially with the respect to health management (Mettler, 2016). Although there are issues with data ownership and exchange processes in past research (Ji et al., 2018). However, this problem can be overcome by the development of this technology which enables patients to own their data and to be able to address who they desire to share the data with (Dimitrov, 2019). This brings an advantage to healthcare firms because currently patients' data are stored by third parties (Hölbl et al., 2018). This technology allows more security in the data management process and prevents the misuse of data (Ito et al., 2018; Alla et al., 2018).

One of the implications of blockchain technology in the healthcare industry is the subject of healthcare management, especially in Electronic Health Records (EHRs), which has the highest capacity for improvement (Angraal, 2017; Hoy, 2017). Overall, the percentage usage of EHRs is approximately 97% worldwide. The information inside EHRs includes medical records, treatments, and clinical progress of patients. Blockchain technology improves EHRs by maintaining both security and privacy in patients' health data (Azaria et al., 2016; Sullivan, 2017; Medicalchain, 2017). One of the greatest benefits of using blockchain in EHRs is that records are stored in a distributed database due to the feature of decentralisation. Data in this system is always kept up to date and records are kept timestamped (BurstIQ, 2017). However, one of the issues that need to be taken into consideration before implementing this technology is the interoperability barrier. This technology does not allow data to be shared with other systems. In addition, other problems associated with this technology are financial

issues, user-related issues, and design flaws (Menachemi et al., 2011).

Furthermore, developing an intelligent healthcare system via blockchain is another aspect to which researchers are currently paying attention. Blockchain is an interesting prospect technology that helps the improvement of e-health (Casado-Vara and Corchado, 2019). Not only does blockchain improve e-health systems, but it also improves telemedical information. This is tremendously beneficial for the provision of healthcare in the future to reach out in a remote area (Hyla and Pejas, 2019; Ji et al., 2018). For instance, the records made by doctors during telemedical appointments could be recorded in the blockchain network to prevent the loss of information and mishandling of data. However, there are problems with this application of blockchain as the validation process might take a long time in order for data to be stored, and lack of research in these areas of application (Hyla and Pejas, 2019).

Interestingly, blockchain can be integrated with other advanced technologies such as artificial intelligence (AI) to generate predictive analytics models for patients' treatment and diagnosis (Mamoshina et al., 2018; Li et al., 2019). For example, blockchain could be used to gather valid and secure data from clinical laboratories, hospitals, and other sources. The AI system then analyses the data from the blockchain and generates a predictive model which promotes the development of new drugs and treatment (Mamoshina et al., 2018). In addition, future research could focus more on this integration topic as there are a number of areas in healthcare where this technology could be applied such as drug prescription management (Hölbl et al., 2018) and digital rights management (Jaoude and Saade, 2019).

V. APPLICATION OF BLOCKCHAIN IN OTHER FIELDS

Due to the immutability of the blockchain, the technology of blockchain is expected to increase in transparency and become more which allowing a more elastic value chain in the supply chain network (Ahram et al., 2017; Kshetri, 2017; Kshetri, 2018; O'Leary, 2017). The blockchain has been accepted in supply chain management (SCM) and logistics (Kshetri, 2018). In addition, the blockchain can be used in the logistics by detecting the knock-off product, tracking the product (Hackius and Petersen, 2017; Kennedy et al., 2017; Lee and Pilkington, 2017; Toyoda et al., 2017; Tan et al., 2018), reduce paper load as well as enabling a direct transaction between the buyer and seller (Subramanian, 2017).

Consequently, it has been shown that the supply chain that using the application of blockchain have improved security

(Dorri et al., 2017a), lead to more comprehensive contract management for combating asymmetry (Polim et al., 2017), enhances tracking mechanisms, and traceability assurance (Apte and Petrovsky, 2016; Tian et al., 2016; Düdler and Ross, 2017; Heber and Groll, 2017; Lu and Xu, 2017; Tian, 2017), giving more reliable information for better information management (Infosys Limited, 2017; O'Leary et al., 2017; Turk and Klinc, 2017), food safety (Ahmed and Broek, 2017) and giving better customer services (Frey et al., 2016a; Frey et al., 2016b). Lastly, it has the potential to enhance smart transportation networks (Yuan and Wang, 2016; Lei et al., 2017; Leiding et al., 2016) and include modern decentralised manufacturing architectures (SyncFab, 2018). In addition, Tradelens is an example of a blockchain-based logistic company (Tradelens, 2018). Tradelens uses blockchain which enables unprecedented transparency, collaboration, and efficiency in global supply chains by providing innovative apps to every stakeholder in the supply chain for controlling and managing data.

Through strengthening, optimizing, and automating enterprise processes, blockchain has the ability to become a major source of innovative developments in business and management (Tapscott and Tapscott, 2017; Bogner et al., 2016; Ying et al., 2018). As the popularity of the blockchain increases in various industries, the European Commission released a report in April 2016 that blockchain will take over the current business model. Based on the Blockchain technology, it was estimated that smart contracts could reduce infrastructure costs by 4.6 billion euros per year by 2022 (Probst et al., 2016).

Moreover, blockchain has the significant potential for product improvement and commercialisation (White, 2017; Klems et al., 2017; Kogure et al., 2017), also improving the trustworthiness in e-commerce. Last but not least, the use of blockchain in the business and industry has improved the progress of the work by better organisation, saving more time and lower cost of the process (Weber et al., 2016; López-Pintado et al., 2017; Prybila, 2017; Rimba et al., 2017; Mendling et al., 2018). For instance, Propertyclub is a real estate company in New York which uses blockchain to improve the way people market and buy and sell properties as well as using a smart contract to conduct transactions digitally using cryptocurrencies (Propertyclub, 2018).

VI. DISCUSSION

As reviewed in this study, there are many benefits of using blockchain technology in healthcare, especially from the perspective of health management where there are lots of potential for growth in development (Mettler, 2016).

Blockchain enhances a secure and transparent environment for the network of patients' data for all hospitals when information is stored in the system. In the traditional method, there are challenges in this data management process as the data might be inaccurate because health records could be altered. This might lead to a reduction in the quality of service and care provided. As a result, our innovation ensures that patients' data and records are safely secured via Hash codes (see Methodology). All records are stored in a form of a block that is irreversible which prevents the risk of fraudulent purpose to patients' medical records. This is an essential benefit as patients' data are currently stored by third parties (Hölbl et al., 2018).

Furthermore, blockchain also enables patients to own their data and to be able to choose recipients with whom they desire to share the data (Dimitrov, 2019). It provides the ability to use the public address and private key to overcome the problem of privacy and confidentiality in patients' records as well as the issue of data ownership and exchange processes in past research (Ji et al., 2018). Not everyone in the decentralised network can access each individual's block, but only people with permission can access the system. This system architecture also prevents the misuse of patients' data.

Moreover, blockchain can aid the interoperability problem due to the characteristics of decentralised networks. One of the major problems in healthcare is the exchange of health data and records across healthcare organisations (Iroju et al., 2013). When patients want to change their health insurance plan or their hospital, new health records must be set up. Oftentimes, these records might be inaccurate and unreliable because this process relies solely on the patients themselves (Baron et al., 2005). This might lead to a reduction in the quality of care given by healthcare providers. Our decentralised blockchain network enables data to be efficiently and securely exchanged. This will solve the problem proposed in the past research regarding the lack of understanding in the interoperability framework (Dagher et al., 2018). In addition, our system contains timestamps; as a result, all of the patients' medical records and their appointment history at any particular time can be accessed electronically and viewed quickly and immediately. Overall, this will strengthen the validity of electronic health records (EHRs) among various medical institutions.

Despite all the advanced features of the blockchain, there are still various hindrances and challenges in the usage of blockchain. Many countries are considering the adoption of blockchain in government settings (Ølne et al., 2017; Hou, 2017). However blockchain is a new, advanced,

complex, and still an immature technology, there are no existing standards or regulations to operate it which can slow down the development of the blockchain-based application (Ølnes et al., 2017). No standardisation of blockchain in the application of healthcare means that the applications that are developed by different vendors on different platforms may make it difficult to cooperate and exchange information.

Furthermore, decentralised storage is one of the core characteristics of blockchain which allows the users to share the data among different services, but this can lead to data leakage. When the user wants to retrieve data from the blockchain, they need to verify their identity by entering the private key or password to decipher the hashed or the cryptographic text into normal text. The cryptographic data are shared by all the individuals who participate and are stored publicly (Zhao et al., 2017). If all the participants team up and use their computational power they can solve the hash and cause data leakage.

Additionally, one of the key problems related to the blockchain is scalability. Due to the advancement of the data analytic tools in medical care and medical imaging, real-time availability of the data, insurance companies, and more, the data are increasing in volume. This rapidly increasing data volume leads to the risk of bulking the overall system, and immense stress on the limited hardware storage, and hence the response time from the system will increase (Gervais et al., 2018).

Moreover, the assumptions made are one of the main constraints in this study. The use of blockchain in healthcare assumes that the patients will always use the smartphone effectively to collect and store their medical data. This is because the devices are not able to verify that the data was submitted by the actual patient or in other words, confirm that the data was submitted by the actual patient (Roehrs et al., 2017).

More importantly, there is another limitation that goes beyond the technical boundaries such as energy consumption, blockchain developers, and cost. Firstly, the validation procedure of blockchain, blockchain is a complex algorithm, which means that several computers are required and need to operate simultaneously. This leads to an increase in the consumption of energy. As a result, this may contribute to the scarcity of the energy supply and cause global environmental issues. Next, initially, the number of people trained in blockchain technology is low but the demand for blockchain is increasing. This is due to the lack of understanding and the availability of resources and technology. Finally, the cost is the primary constraint of the blockchain. There are many costs that hinder development such as protocol cost and the execution cost

based on variable inputs of string length and size (Al Omar et al., 2019).

VII. CONCLUSION

The study above aims to advance existing trends of blockchain into healthcare. To provide an alternative route for all hospitals, all healthcare departments, all healthcare professions, and all patients to combine as one family network. The findings are merged to synthesise a transparent network that provides reliable security and privacy of data, efficient eco-storage, and approachability by components in blocks such as consensus algorithm of hash values ('Proof-of-space') and decentralisation.

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Endodontic Intervention in Single Session on Patients with Need for Endodontic Treatment

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Abstract— Endodontic treatments have evolved in order to prepare the root canal system to receive an airtight filling of this system and thus preserve the health of the periapical tissues and / or restore it, when affected by injuries. Such goals are achieved through obedience to an appropriate chemical-mechanical preparation of the root canals, followed by filling them. The aim of this study is to perform endodontic intervention in a single session in patients in need of endodontic treatment. Fifty patients were treated at the ITPAC / FAPAC - Porto Nacional multidisciplinary clinic, asymptomatic and in need of treatment or endodontic retreatment. In all cases, anesthesia was performed with 2% lidocaine, absolute isolation, irrigation with 2.5% sodium hypochlorite, preparation of the cervical third with the Logic 25/05 rotary system, confirmation of the working length and foraminal patency with locator foraminal Root Zx, instrumentation of the apical third with Logic 25/05 system, final irrigation with agitated 17% EDTA with 25 IRRS ultrasound insert (VDW Endo Ultrasonic Files, Endodontic Synergy, Munich, Germany) at a frequency of 30 kHz for 20 seconds, connected to a piezoelectric device. After complete chemical-mechanical preparation, the thermoplasticized filling was performed in a single session. Then, coronary rehabilitation with composite resin was performed. Proreservations of 1, 3, 6 months were carried out to analyze the regression of the infectious process and repair of the apical third. In the immediate postoperative period, 15% of the patients had spontaneous pain, however the incidence of severe pain, flare-ups, was around 5%. At 6 months, all patients were asymptomatic and without fistulas, however, only 60% had complete resolution of the periapical radiolucent areas. Therefore, in the medium term, endodontic treatment in a single session provided 100% of clinical success, but reduced percentage of radiographic success.

I. INTRODUCTION

The main objectives of endodontic treatment are the resolution of pulp or periapical inflammation. In order for these objectives to be achieved, the space occupied by the pulp tissue will undergo professional intervention. For the endodontic treatment to be properly performed, it is essential to have a three-dimensional knowledge of dental

anatomy including the number of roots, number of channels, location of them, pulp cavity shape, in addition to the possible curvatures and anatomical singularities that can be found in different cases to be treated (Bergenholtz, 2016). Pineda and Kuttler (1972), stated that in order to unblock, prepare and fill the root canal correctly, it is necessary to know details of its internal morphology. On

the other hand, the performance of endodontic interventions without this knowledge can lead to failure and sometimes to the loss of the dental element.

The need to provide the student with the integral and interdisciplinary concept of the profession is imperative, aiming at the training of general practitioners able to prevent, diagnose, plan, predict, execute and evaluate integrated dental treatment plans (Martinho et al., 2017).

The integration of endodontics and oral rehabilitation aims to develop in the student the ability to integrate the knowledge and practice of his / her learning, carried out in the specific subjects previously taken. Thus, the knowledge, skills and attitudes already acquired in isolation should be gathered logically and sequentially ordered, in order to perform most dental clinical procedures, providing the patient with a favorable and more predictable prognosis (Brignardello-Petersen, 2017).

However, the repair of lesions with immediate canal filling, in just one session, is possible to be performed (Tanomaru et al., 2002). Segura-Egea et al. (2015), promoted a systematic review investigating the effectiveness and complications of patients treated endodontically in one visit and in multiple visits. Twelve studies were included in this review and concluded that there was no significant difference between the two therapies evaluated in terms of radiographic success.

Recognition of complications will greatly contribute to the quantity and quality of clinical work, as the best effort on the part of the faculty will be dedicated to those causes that, significantly, compromise the realization of the treatment plan initially proposed. This will result in the improvement of the teaching-learning binomial, as well as in the satisfaction of the student and the patient (Martinho et al., 2017).

In this context, the objective of this study is to perform endodontic intervention in a single session in patients in need of endodontic treatment.

II. MATERIAL AND METHODS

The study refers to a descriptive, qualitative and quantitative and longitudinal research to analyze the quality of endodontics performed in a single session.

Fifty patients were selected who needed endodontic treatment of both genders and aged between 18 and 59 years. Endodontic treatments were performed in a single session, with equipment that helps in the quality of our work (use of rotary motors, foraminal locator, digital x-ray), reducing the number of consultation sessions, which provided tooth disinfection, avoiding tooth loss.

dental element and streamlined its oral rehabilitation, these patients underwent preservation which in this case is the radiographic follow-up after endodontic treatment to obtain the final result of this study.

Initially, anamnesis was performed, according to the form, intra and extra-oral clinical examination and periapical radiographic evaluation (use of radiographic positioner).

All of these procedures were performed at the dental clinic of FAPAC / ITPAC Porto.

The service protocol was performed as follows:

Initially, anamnesis, tactile inspection and periapical radiography of the dental element were performed, followed by anesthesia with Lidocaine 1: 200000 (Dentsply / Sirona, Ballaigues - Switzerland). Afterwards, tooth prophylaxis will be performed with a straight white AC brush (Microdont, Socorro - SP) and Herjos prophylaxis paste (Vigodent, Rio de Janeiro - RJ), caries removal with low rotation spherical drills (Dentsply / Maillefer, Ballaigues - Switzerland) and coronary opening with 1014 and 3082 drills (KG Sorensen, Barueri - SP).

The absolute isolation was done with a rubber sheet (Madeitex, São José dos Campos - SP), Ostby isolation arch (Prisma, São Paulo - SP) and various isolation clamps (KSK, Rio de Janeiro - RJ) disinfecting the operative field with 0.2% chlorhexidine (A Fórmula manipulation pharmacy, São Paulo-SP).

Initial exploration with K file # 10 or 15 (Dentsply / Sirona, Ballaigues - Switzerland) was carried out up to the apparent length of the tooth. Instrumentation technique to be performed will be with the Prodesign Logic 25/05 engine and rotary system (Easy, Belo Horizonte - Brazil), followed by the preparation of the cervical third with Prodesign Logic 25/05 files (Easy, Belo Horizonte - Brazil) towards the crown - apex respecting the anatomy of the canal, always maintaining a minimum distance of 5mm from the apical limit on the radiography and in curved channels until the beginning of the curvature. Next, dentistry was performed with Root ZX foraminal locator (J Morita, Kyoto - Japan), obtaining the actual tooth length. A foraminal patency was performed with the Prodesign Logic 25/01 rotary file (Easy, Belo Horizonte - Brazil) 1 mm beyond the actual tooth length, defined by an electronic foraminal locator. Patency check with file (10 or 15). Subsequently, a Prodesign Logic 25/05 file (Easy, Belo Horizonte - Brazil) will make the apical stop 1 mm below the actual length of the tooth, thus establishing the working length.

Throughout the instrumentation, irrigation was performed with 2.5% sodium hypochlorite (Manipulation Pharmacy - Formula and Action - São Paulo - SP), Luer Slip 10 mL plastic syringe (Advantive, Nanchang Jangxi - China) and disposable needle 25 x 0.55 (BD, Curitiba - PR). 30 mL of solution will be used per experimental unit. The needle will be inserted throughout the instrumentation process until it reaches 2 mm below the working length.

The channels, at the end of the preparation, were dried with capillary tips (Ultradent Products, Inc, South Jordan, Utah, USA) coupled to a high-powered sucker and with absorbent paper cones (Tanari, Manacapuru - AM).

The final irrigation was carried out with 3 mL of 17% EDTA (Pharmacy of manipulation - Formula and Action - São Paulo - SP). First, 1 mL of 17% EDTA was introduced, followed by ultrasonic vibration with a 25 IRRIS insert (VDW; Endo Ultrasonic Files, Endodontic Synergy, Munich, Germany) at a frequency of 30 kHz. The ultrasound insert was connected to a piezoelectric ultrasound operating at 30 kHz (CVDent 1000; CVD Vale, São José dos Campos, SP, Brazil), set at power level 3, over a period of 20s. This process was repeated 2 more times. After this process, irrigation was carried out with 5 mL of sodium hypochlorite (Farmácia Fórmula & Ação, São Paulo - SP). The channels were dried with capillary tips (Ultradent Products, Inc, South Jordan, Utah, USA) coupled to a sucker high power and with absorbent paper cones (Tanari, Manacapuru - AM).

The sealer that was used will be AH Plus (Dentsply / Sirona, Munich, Germany) and will be mixed according to the manufacturer's recommendations.

The channels were filled, in the same session, by the Continuous Condensation Wave technique (Buchanan, 1994) which follows the principles of the Schilder technique (1967) using the Touch'n Heat equipment. For this purpose, accessory M and FM cones (Tanari, Manacapuru - AM) were selected. These were calibrated using a calibrating endodontic ruler (Dentsply / Maillefer, Ballaigues - Switzerland) and adjusted to the working length. The Thermoplasticizer of the Touch'n Heat device performed cutting, plasticizing and condensation of the gutta percha within the channels, up to 11 mm, inside the root canal. This filling phase is called "Down Packing". Subsequently, the "Back Fill" phase was performed with the insertion of plasticized gutta percha with the aid of Easy Pack (Easy, Belo Horizonte - Brazil).

Definitive restoration of composite resin or glass ionomer cement was performed after treatment and final radiography was performed with a radiographic positioner (Indusbello, Londrina - PR). The dental element was

preserved in 1 month, 3 months, 6 months, analyzing the regression of pathology and symptoms.

The disposal of the materials used in this study was inserted in a hospital garbage bag (Azeplast Indústria e Comércio Ltda., Santa Catarina - Brazil), made according to ANVISA standards, after the completion of the laboratory procedures for this research. The bag of hospital waste, with biological material, was presented to the sector for the disposal of material with biological risk from ITPAC / FAPAC - Porto Nacional to be discarded, following the rules of ANVISA.

III. RESULTS AND DISCUSSION:

Endodontic treatment in a single session on teeth with furcation lesions of 50 patients is enabling the healing process of dental elements. Below is one of the clinical cases with 3-month preservation (Figure 01 - Initial radiography, figure 02 - Initial clinical examination (presence of Parúlido), figure 03 - Root canal filling in a single session, Figure 04 - Immediate restoration with composite resin, Figure 05 - Preservation for one week (absence of Parúlido) and Figure 06 - Preservation for 6 months.



Fig.1: Initial radiography



Fig.2: Initial Clinical Examination (presence of Parúlido)



Fig.3: Root canal filling in a single session



Fig.4: Immediate restoration with composite resin



Fig.5: Preservation of one week



Fig.6: 6-month preservation

Moreira et al (2017) performed a systematic search was performed in the electronic databases MEDLINE/PubMed and Cochrane Central Register of Controlled Trials until August 18, 2016, without language restriction. The eligibility criteria were as follows: (1) systematic reviews (SRs) and (2) a focus on endodontic techniques in single or multiple visits. The phases of eligibility and analysis of risk of bias were conducted by 2 or 3 independent and calibrated examiners, and a fourth examiner was consulted to resolve inconsistencies. Assessment of Multiple Systematic Reviews was used to evaluate the risk of bias of the included SRs, which were assessed according to the risk to develop knowledge and the existing knowledge gap. The main characteristics including healing rates, success, and clinical complications during and after endodontic treatment were extracted from the SRs. From the 20 SRs initially identified, 8 were included in the analysis. Of these, 6 SRs showed low to moderate risk of bias and were suitable as strong clinical evidence on the topic. Overall analysis indicated that single and multiple visits showed similar repair or success rates regardless of the precondition of the pulp and periapex. The apical periodontitis subgroup showed a slight positive trend toward a decreased incidence of postoperative complications and a higher effectiveness and efficiency for a single session. In this research it was possible to observe regression of the infectious process and symptomatology in the periods of preservation, corroborating with the study by De Deus et al., 2016.

Nagata et al., 2017 investigated the total number of visits required to conclude root canal treatments (RCTs) as well as the motivations associated to the choice of dentists practicing in low-income areas of Brazil. A total of 3,103 questionnaires were electronically and individually delivered to professionals of Salvador, Sergipe, and Alagoas (Brazil). The questionnaire encompassed sociodemographic data and questions regarding the number of sessions required to conclude RCT. Also, postoperative pain, professional qualification, the use of technological resources, and time for one-visit treatment were evaluated. Data were analyzed using Chi-square and Poisson regression analyses ($p < 0.05$). A total of 326 responses were obtained with higher prevalence of specialists in the field of endodontics (36.8%). Dentists reported greater preference for rotary instrumentation (Alagoas 54.6%, Aracaju 62.1%, and Salvador 83.5%), and most of the participants reported multiple visits to treat root canals with the necrotic pulp tissue associated or not to periapical radiolucency, excluding Salvador (53.8%). Dentists who graduated in public dental schools were less likely to perform RCT of necrotic teeth with periapical lesion in one clinical appointment ($p = 0.034$). The single-

session therapy was positively associated to continuing education attendance ($p = 0.004$) and to the occurrence of clinical complications ($p < 0.001$). Dentists who graduated in *lato sensu* programs were more likely to conclude RCT in less than 60 minutes ($p < 0.001$), although the occurrence of postoperative pain was more likely observed upon this scenario ($p < 0.001$). It was possible to conclude that despite the social inequalities in the analyzed area, professionals have been seeking for knowledge by means of continuing education programs and the implementation of technological resources in their clinical routine, although this fact has poorly influenced the acceleration of RCT. This study agrees with the work of Albuquerque et al., 2019. The present study found satisfactory results of treatment in a single session, the number of flare-ups was reduced and regression of symptomatic conditions and periradicular lesions.

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The Contractor's Responsibility and the Perspective of the Outsourced Service Providers of the Federal Institute Minas Gerais - *campus* Ouro Preto: influences that can affect the quality of the service provided

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Keywords— *Contract's supervisor profile; Competency Management; Outsourcing in Public Administration.*

Abstract— *The use of outsourced labor appeared in the Brazilian Public Administration in the mid-1950s aiming at the gain with the quality of the processes, the possibility of reducing costs and increasing productivity. It has intensified since 1990, particularly in federal universities via public bidding. In order to manage or supervise a contract, specific knowledge in different areas should be required, in addition to an adequate profile, whose skills and competences are not always observed when they are appointed, since the quality of the inspection of contracting passes through your hands. The present study sought to identify the extent to which the contract inspector's commitment interferes with the conduct of service providers. The research methodology is quantitative and of an applied nature, with exploratory objectives, experimental and bibliographic procedures, developed within the scope of the Federal Institute Minas Gerais - campus Ouro Preto, with outsourced service providers. Questionnaires and statistical notes were used as a means of data collection. From the results, it will be possible to develop an action plan with improvements and solutions applicable to the local reality, in addition to replication in other institutions where the Contractor operates. Theoretically, three topics were covered: outsourcing and relevant legislation; the function of the supervisor of outsourced service contracts; and management by competence.*

I. INTRODUCTION

Public organizations have long been thought as a company within the scope of administration and, as such, have adapted mechanisms from the business sector to promote efficiency and quality in the provision of services to society. This research for new practices to improve performance inevitably goes through the outsourcing

process, in which the use of specific labor is opted for, however, the contracting organization is directly disconnected from the service provider.

It should be noted that outsourcing cannot be understood as a service purchase relationship, where one company acquires service from another. It consists of a structured form of organization, where the exchange of

information, coordination and credibility on either side becomes essential.

The legal basis for the outsourcing process finds a framework in Law No. 8666/1993, that regulates article 37, item XXI, of the Federal Constitution and establishes rules for bidding and contracts of Public Administration and other measures, among which the power to inspect the outsourced service in order to require continuous, quality, punctual and efficient consideration, as well as, in Decree No. 9507/2018, articles 10 and 11.

For that, the legislation itself in its article 67 determines that: "The performance of the contract must be monitored and inspected by a specially designated representative Administration [...]" [1]. Such inspection is given by the figure of the manager and the inspector of the contract.

It is noteworthy that the manager or the inspector of the contract, is a specially designated person, and is not entitled to deny it, because it is the primary function to the public servant and for the fulfillment of the contract, having as a parameter the result provided in the bidding documents, it must have a proactive and preventive behavior, enforcing the rules provided for in the contractual instrument [2]

However, for the organization to identify such competencies and abilities in order to promote a good choice of manager or inspector, it is necessary to make use of Knowledge Management instruments, which are not always part of Public Administration.

Furthermore, as it is an activity that does not add any pecuniary or meritocratic advantage to the inspector, on the contrary, being treated by the vast majority as a nuisance that no one wants, it is relevant to highlight the responsibilities of the inspector and the vision of outsourced service providers who are object to inspection, in order to reveal difficulties and victories of those who are predisposed to do so, before the community in which it is inserted

II. HEADINGS

2.1 OUTSOURCING IN PUBLIC ADMINISTRATION

Outsourcing in the Public Administration of Brazil began in the 1950s, through the implementation by the federal government of the Goals Plan, whose objective was to accelerate economic growth through industrial expansion. Still in the middle of 1967, the Brazilian government issued Decree No. 200/67 that determined the decentralization or indirect execution of operational activities, by means of a contract with qualified companies, whose purpose brought in article 10, paragraph

7 was to "prevent disproportionate growth of the administrative machine" [3]. This outsourcing should be complied with under specific conditions.

Subsequently, outsourcing received support from the Federal Constitution of 1988, through article 37, item XXI, in which, in which it admitted, from then on, the contracting of services by the Public Administration outsourced by conducting the bidding, however, it was only with the regulation of the bidding process, which occurred under Law No. 8666/93 and later, from 1995, with President Fernando Henrique Cardoso and the creation of the Ministry of Federal Administration and State Reform, that outsourcing exploded.

In mid-2018, the government of President Michel Temer, through Decree No. 9507/2018, promoted new amendments to Law No. 8666/1993, giving it a more updated character to the existing realities in Public Administration.

Conceptually, Giosa [4] defines the term Outsourcing as "a management process through which some activities are passed on to third parties - with whom a partnership relationship is established - the company being concentrated only on tasks essentially linked to the business in which it operates".

In Kinczeski's [5] conception, the outsourcing is the contracting of services through an intermediary company, that is, the contractor transfers to a third party the execution of services that could be performed directly, through a service provision contract.

It can be said that outsourcing is contracting, through a bidding process by specialized companies that will carry out activities not directly linked to the main activity of Public Administration. Impersonality, autonomy and the eventuality of the service provided are presented as differences between employment relationships and outsourcing relationships.

Even though the outsourcing process is legal, it is not intended for all areas and activities. The limitations imposed by law direct the outsourcing process to the service activities of conservation, cleaning, security, surveillance, transport, information technology, catering service, reception, reprography, telecommunications, maintenance of buildings, equipment and facilities.

The outsourcing process presupposes the existence of a planning from the moment it is defined by its use, a monitoring of its implementation and mainly the management during the contracted period, since there is, until then, no clear measurements of the benefits previously mentioned (cost savings, level of quality of services provided).

It is enumerated as advantages that outsourcing is justified by reducing the cost of the Public Administration, increasing competitiveness, better quality of the contracted service. However, many of the disastrous and fruitless experiences for organizations in relation to outsourcing are the result of organizational immaturity.

The possibility of labor and social security defaults, non-qualification of the contracted company, companies whose capacity to comply with the proposal is unworkable, poor quality of the execution of the contracted activities stands out as negative points to outsourcing.

Due to the negative points previously presented, Marinho *et al.* [6] justifies: "... these factors lead to reflect on the need to develop and maintain an efficient contract management policy, based on variables that satisfy and meet the dynamism currently required from the public sector".

In this sense, Law No. 8666/93, presents in its text, article 67, states that "The execution of the contract must be monitored and inspected by a specially designated representative of the Administration [...]" [1], consequently, when entering into a service provision contract, the Administration is vested with the power-duty to inspect the service in order to require a general, permanent, regular and efficient provision.

In Almeida's [7] observation: "when he mentions that the management and inspection of outsourced services is a true Achilles' heel of the public administration in Brazil, causing good bids and contracts to be rarely lost due to the interference of outsourcing".

Then comes the figure of the inspector, a servant designated to verify the ideal contractual execution, ensuring that public resources are being used and minimizing the risks inherent to outsourcing.

2.2 THE CONTRACT INSPECTOR

The manager or inspector of the contracts is the servant on the part of the Public Administration, formally appointed by the expenditure originator, who will monitor the contractual execution. Such designation shall be part of the contractual instrument, emphasizing that the choice must fall on those who have greater technical experience related to the object of the contract. The indication of who will assume this responsibility, on the part of the primary originator, must occur in the internal phase of the bidding process, that is, prior to the choice of the company that will provide the service.

Since Law No. 8666/93 dealt briefly with the issue of monitoring and inspecting contracts and its profile of this figure, the Ministry of Planning, Budget and

Management was responsible for its regulation, through the publication of Normative Instruction 02/2008, of April 30, 2008 and subsequent amendments. The Normative Instruction tries to guide the inspection practices by setting parameters and procedures for the agents involved through articles 31 to article 35.

It is worth mentioning that some agencies differentiate the agents in charge of the inspection, dividing them into managers and inspectors, although this practice does not apply to all bodies of Public Administration, with the responsibility of a single employee, the attribution of all activities.

For information, according to the Manual of Management and Outsourcing Services Contract Supervision of Enap [8], we have the following attributions:

CONTRACT MANAGER: server formally appointed by the Internal Management Directorate to monitor and coordinate the activities of the inspectors and receive the service definitively (act that concretizes the certificate), after analyzing the reports presented by the technical and administrative inspection. It is also responsible for the initial or preparatory procedures, in order to forward to the contracts sector the acts related to: extensions, alterations, rebalancing, payments, possible sanctions and termination of the contract. **CONTRACT TECHNICAL INSPECTOR:** server appointed by the Demanding Services Area, formally appointed by the Internal Management Directorate, to monitor and supervise the execution of outsourced services, confer the compliance and quality of the services provided, performing the provisional receipt of services; **CONTRACT ADMINISTRATIVE INSPECTOR:** servant formally appointed by the Internal Management Directorate to monitor the execution of outsourced services, with regard to the monitoring of the contractor's compliance with labor, social security and tax obligations, as well as provisionally receive the service.

Activities such as contract inspector suggest initial meetings with the contractor in order to define technical issues; the intensive inspection of the contractual length monthly on a daily basis; measuring monthly results; analysis and storage of contractual history; promotions of contractual adjustments with a view to collective agreements or legal impositions, application of sanctions when detecting irregularities, extensions and terminations of the contract within the stipulated period. It

is attributed to the contract inspector, according to article 16, paragraph 2 of Law No. 8443/1992 the joint liability of the supervisor to the contractor's acts for possible damages, caused by the irregular execution of the contract.

Exposed some activities, it is noticed that for the full exercise of the function, the inspectors of outsourced service contract must have knowledge in different areas, such as technician on the contracted object, tax legislation, labor, social security, bidding, budgeting, accounting, applications related to people management, among others.

In addition to this knowledge, it is important to highlight some desirable skills to the profile of the public servant in order to better manage the processes where the outsourced service provider is necessary.

It would be certain to conclude that for a management in its full conception and to require the servant assigned to the inspection to comply with the entire list of attributions that are pertinent to it, there would be a concern with the adequacy of the inspector's profile, the development of individual and specific skills, as well as technical training, in addition to a structure that could give it adequate working conditions for the good practice of contract inspection and, mainly, valuing the activity and the professional who performs it.

In the case of detection of deficiencies and technical limitations, and of a profile that may prevent diligent fulfillment of the exercise of their assignments, the main manager of the administration should, first, provide the qualification of the server for the performance of the assignments, according to the nature and complexity of the object, as well as using knowledge management tools in order to enhance the knowledge of the professionals, or, in the impossibility of such procedures, designate another servant with the required qualification.

However, in most cases, almost none of this occurs. What has been seen are unprepared inspectors, with no autonomy of action, overloaded with assignments, since in addition to the inspector activity, the civil servant still accumulates the daily attributions of his area of activity since it is a legal imposition, there being no possibility negative, as it is a legal order.

2.3 KNOWLEDGE MANAGEMENT

All the changes that the Public Administration has experienced over the last 20 decades, go directly through the mental map of civil servants. Today it is necessary for the public servant to have a more holistic view, ceasing to be a specialist and becoming a generalist, with multiple knowledge in economics, public finance, public accounting, controllership, strategic planning, information and communication technology, among

others, in addition to remain in a constant process of training and acceptance of the new rules.

Knowledge management and competence management in terms of results in the public spheres, even if difficult to measure, are extremely relevant, although the processes derived from the use of these theories are not yet fully inserted in most public institutions, according to Carbone *et al.* [9], due to their complexities.

The discussion about knowledge is not a new fact. Maturana; Varela [10] point out in the Bible, references on the theme: "When Adam and Eve ate the fruit of the knowledge of good and evil, they found themselves transformed into other beings and never returned to the old innocence [...] they knew it if naked, they knew they knew".

Passing through the Celtic civilization, who credited immortality, knowledge and knowledge to the apple, we arrived in Ancient Greece, from where one of the first definitions of knowledge came from Plato justified true belief. Over the centuries other authors have tried in vain to define knowledge. From the 1920s, Carbone [9], argued that knowledge is a relationship between subject and object, where through knowledge it apprehends the object and, at the same time, the object conditions the subject who apprehends it. At the end of the 20th century, Plato's definition comes back to the fore, now brought by Nonaka and Takeuchi [11] for the construction of the theory of knowledge creation, consequently becoming, in the first reference to what we now know as Knowledge Management Theory: We are what we do.

The resource-based theory originates from the work of the English economist Penrose [12] who emphasizes the limits and possibilities of firms' internal resources to generate market imbalance, from which companies can obtain competitive advantages.

For Cherman; Rocha-Pinto [13] knowledge is still a little valued resource within organizations and, therefore, unable to promote valuation of strategic innovation results or individuals' performance.

This theory explains the difference in performance between companies based on heterogeneity and their resources. This means that the basic source for competitive advantage is the resources and skills developed and controlled by organizations, that is, the valorization of professional knowledge, scarce, valuable elements, difficult and costly to imitate and replace, according to Barney (1991 *apud* CARBONE, [9]).

Managerial knowledge and the ability to learn in organizations have come to be considered engines of strategic change, that is, in the long term, the sustaining of

competitive advantage has come to depend on a superior (managerial) ability to identify, build and leverage new competencies, consequently making the ability to learn a critical strategic variable to the success of an organization.

The Public Administration has recently assumed the field of competences and positive results have been observed in effectiveness, since there is concomitant clarity of rules, clear and comprehensive communication with civil servants, in addition to tailored training and development processes.

However, this process is still timid and involves, mainly, the change in the profile of the high-level leaders of organizations, which in many cases is seen with their hands tied, since politics is something intrinsic to public organizations.

Competence, meritocracy, appropriate profile for the activity are still taboos, but they need to be incorporated in order to be able to extract from public servants, their best behaviors towards society, especially when they are in functions aimed at inspection, as is the case of server designated as contract inspector, consequently taking into account the constitutional principle of transparency, the principle of fiscal management, corroborating the dual efficiency and effectiveness in public administration.

III. RESEARCH METHODOLOGY

For this work, we opted for quantitative and applied research, with exploratory objectives, whose procedures will be experimental and bibliographic, to be developed within the scope of the Instituto Federal de Minas Gerais - *campus* Ouro Preto (Federal Institute of Minas Gerais – *campus* Ouro Preto), with the outsourced service providers of the Companhia ADCON - Administração e Conservação Eireli¹ (ADCON Company - Administration and Conservation Eireli).

In the opinion of Hernandez Sampieri *et al.* [14]:

The quantitative approach uses data collection to test hypotheses, based on numerical measurement and statistical analysis to establish standards and prove theories.

It uses data collections without numerical measurement to discover or improve research questions in the interpretation process.

With the quantitative research, the aim is to generalize the results found in a segment group (sample) to a larger community (population) and still allow the studies carried out to be replicated. It is important to remember that quantitative research occurs in the external reality of the individual, which leads us to an explanation of how reality is understood through this research approach.

The research is also of an applied nature, which according to Gerhardt; Silveira [15] aims to generate knowledge for application in practice, addressing the solution of specific problems and involving local truths and interests.

Regarding the objectives, it is an explanatory research. According to Gil [16], explanatory research is concerned with identifying factors that determine or contribute to the occurrence of certain phenomena, therefore, it explains the reason for things through the results it offers to the researcher.

The procedures to be developed use experimental and bibliographic research. In Gil's perception [16], experimental research consists of determining a study objective, selecting variables that would be able to influence it, defining ways to control and observe the effects that the variables are capable of produce on the object.

Within the population context, the research was conducted with 88 service providers that make up the framework of the Companhia ADCON, gathered to the Instituto Federal de Minas Gerais - *campus* Ouro Preto.

The formula described below, whose accepted reliability index is 95%, was used to calculate the sample.

$$n = \frac{Z^2 \times p \times (1 - p)}{d^2}$$

Z = level of confidence according to the standard normal distribution (95% confidence level)

p = estimated proportion of the population that presented the attributes in the research

1 – p = (estimated proportion of the population that have not presented the attributes in the research)

d = tolerated margin of error

n = sample size

The resources of the Microsoft Office Excel application were used to tabulate the data collected in the interviews. From the collection, treatment and

¹ Eireli: Acronym designate for Individual Limited Liability Company. It is a type of company that is formed by a single partner, that is, by the entrepreneur himself who wants to open a business and be the sole owner and whose regulation was given by Law No. 12441/11.

compilation of the data, an attempt was made to diagnose the current situation.

IV. RESULTS AND DISCUSSION

The studies took place at the Instituto Federal de Minas Gerais - *campus* Ouro Preto, created by determination of Law No. 11,892 of December 29, 2008, as part of the policy of expanding professional education in Brazil, originating from the Escola Técnica de Ouro Preto (Federal Technical School of Ouro Preto), a 77 year old institution, together with the company hired to provide outsourced services, Companhia ADCON - Administração e Conservação Eireli, a company with patriarchal roots in Minas Gerais and present in the market since 2001.

Currently, the contract has 88 outsourced service providers at various stations: conservation, cleaning, surveillance, transport, information technology, catering service, reception, maintenance of buildings, equipment and facilities.

Following the adopted methodology, 88 questionnaires were delivered by print or electronically to service providers, of which 63 questionnaires returned, which points to 71.6% of responses. Since the confidence interval adopted was 95%, which represents about 71.75 responses, it is believed to have achieved the proposed objectives of sampling and reliability.

Of the 63 interviewees, only 1 claimed not to know the contract inspector. And with regard to the knowledge of the functions pertaining to the inspector, 60.31% stated that they know little about the contract inspector's function and know what he does, while 33.33% claimed to know the function and know what he does. Only 4.76% did not know how to give their opinion and 1.58% of the interviewees said they were totally unaware of the function of the contract inspector.

Graphic 1 - Perception about the function of the contract inspector.



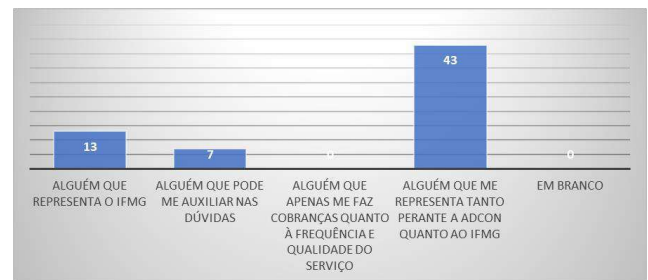
Data source: Research result, 2021.

However, when asked directly about some of the activities belonging to the contract inspector (Graphic 1) only 6.34% pointed out all the activities described in the questionnaire as being the function of the inspector, while

most of the interviewees shared their opinions in relation to the other activities, which demonstrates that, although the outsourced service providers are aware of the activities developed, they do not have sufficient knowledge about the activity developed.

It corroborates with this affirmative the answers presented for the question about how the service provider sees the inspector, where the majority (71.42%) understand the contract inspector as someone who represents both the Contracting Institution (Instituto Federal de Minas Gerais - *campus* Ouro Preto) and the Contracted Institution (Companhia ADCON). It is necessary to mention that no outsourced service provider claimed to see the inspector as someone who charges for the frequency and quality of service, which is one of the activities to be developed by the same (Graphic 2). It also shows that part of the interviewees (19.04 %) believes that it is up to the inspector to represent only the Instituto Federal de Minas Gerais - *campus* Ouro Preto.

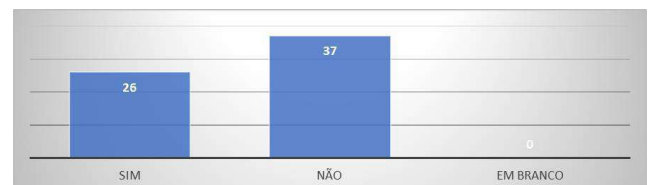
Graphic 2 - View about the person of the contract inspector.



Source: The author, 2021.

When questioned about having already sought the contract inspector at some point (Graphic 3), it can be seen that the majority (58.73%) claims to have never sought it and, conversely, 41.26% of service providers claim to have already sought the contract inspector at some point.

Graphic 3 - Positioning when the search for inspector by outsourced service providers.



Source: The author, 2021.

Asked about the possibility of seeking the inspector when there is a doubt to solve it, the outsourced service providers showed a balance of behavior (Graphic 4). Most claim never to seek and a slightly lower margin,

claiming that they have none problem with looking for the inspector to solve your problems. Within this approach, a very small portion reported that even if they feel embarrassed, they look for the inspector or ask a colleague to help them resolve their doubts with the inspector.

Graphic 4 - Behavior of outsourced service providers in relation to doubts.



Source: The author, 2021.

When approached about the freedom they feel to ask their questions to the inspector (Graphic 5), the majority of respondents answered that they always feel attended by the inspector and a small minority stated that they were not free to ask questions or do not know how to give an opinion on the subject.

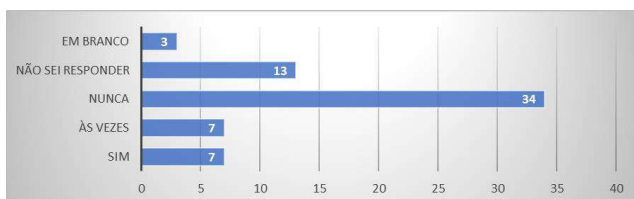
Graphic 5 - Feeling of freedom of outsourced service providers to ask questions to the contract inspector.



Source: The author, 2021.

Questioned about the sensation of having their performance in their activities interfered by the contract inspector, a balance is perceived between the views, with the majority (42.85%) believing that the inspector never interfered in their activities (Graphic 6) and a slightly smaller portion (34.9%), say they are unable to answer the question. Among those who claim that there is interference by the inspector in their activities, even if sporadically, there is a percentage of 20.63.

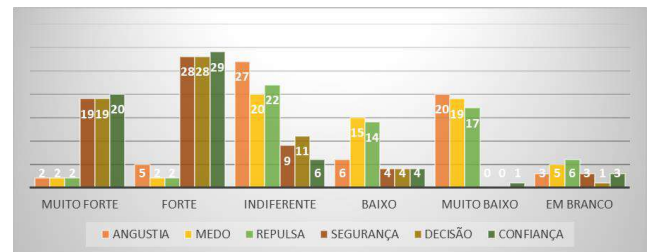
Graphic 6 - View of outsourced service regarding possible interferences of the contract inspector.



Source: The author, 2021.

The identification of the feelings caused by the contract inspector in outsourced service providers can be seen in Graphic 7, was divided into negative feelings (anguish, fear and repulsion) and positive feelings (security, decision/resolution and confidence). A separate analysis of each sentiment made it possible to ascertain that, with regard to the feeling, there is a balance between service providers who say they are indifferent and those who consider the feeling of anguish very low in relation to the contract inspector. In the same way they behaved in relation to the sensation of fear, having a balance between a very low sensation and indifference. Following the same line, the feeling of repulsion for the contract inspector.

Graphic 7 - Perception of the feelings of outsourced service providers regarding the behavior of the contract inspector.

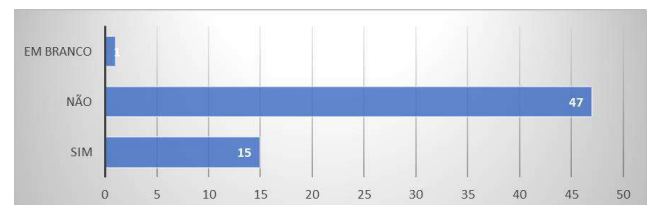


Source: The author, 2021.

It is still possible to infer that for the positive sensations (Graphic 7) the preponderance between the feeling that the contract inspector transmits a very strong or strong security is imperative. The same interpretation is given when the feeling is the power of decision/resolution and the feeling of confidence.

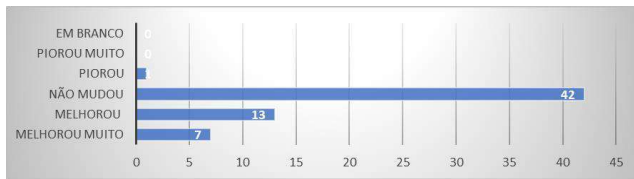
Regarding the pandemic period experienced by society (Graphic 8 and Graphic 9), most of the interviewees pointed out that they had not undergone any change in the performance of the contract inspector, nor did they perceive changes either positive or negative in the inspector's behavior of the contract inspector.

Graphic 8 - Positioning of outsourced service providers in relation to the perception of the contract inspector's performance or not during the pandemic.



Source: The author, 2021.

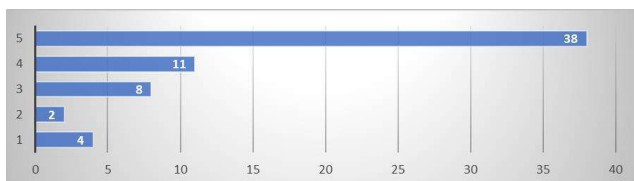
Graphic 9 - View of outsourced service providers in relation to the perception of the contract inspector performance during the pandemic.



Source: The author, 2021.

When giving a score for the performance of the contract inspector (Graphic 10), the majority inferred the maximum score, and only 4 of the interviewees rated the inspector's behavior as a minimum.

Graphic 10 - Score attributed to the contract inspector during the pandemic.

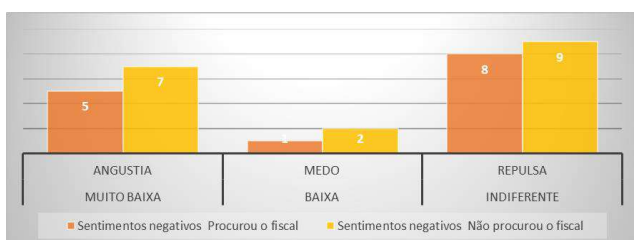


Source: The author, 2021.

For a better understanding of the results, correlations were made between some questions.

The negative feelings caused to those who said they had never sought the inspector were analyzed, and the feeling of indifference prevailed and, subsequently, the very low feelings, when the feelings of anguish, fear and repulsion prevailed (Graphic 11). Such behavior denotes two possibilities of analysis. First, the allegation of indifference actually hides a fear of seeking the inspector, where by not assuming a position, it would avoid future problems. Second, the non-demand for the inspector comes from personal characteristics or other feelings not questioned in the research.

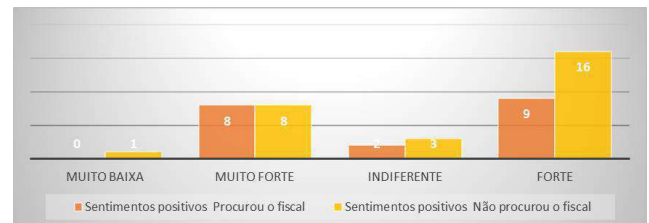
Graphic 11 - Correlation between negative feelings and whether or not by the contract inspector.



Source: The author, 2021.

With regard to positive feelings (Graphic 12) among those who said they had sought the contract inspector, it was possible to ascertain that the majority claims to have very strong or strong feelings. For those who have never sought the contract inspector, surprisingly, the percentage of interviewees who claimed to feel security, decision/resolution and confidence represents the majority. Hence it can be inferred that even though they did not need the assistance of the inspector at some point, they feel represented and protected by the inspector's performance.

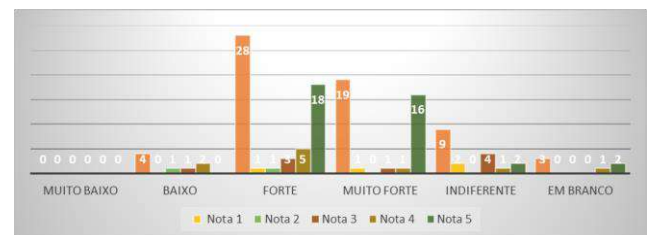
Graphic 12 - Correlation between positive feelings and whether or not by the contract inspector.



Source: The author, 2021.

For the correlation between the positive feelings and the maximum score, it is noticed that the service providers highlight the feeling of security (Graphic 13), being strong and very strong for most. The same can be extended to the feelings of decision/resolution and confidence, with the strong option of feeling is predominant.

Graphic 13 - Correlation between positive feelings of security and attribution of score.

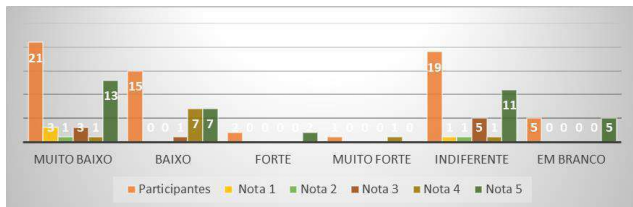


Source: The author, 2021.

When the data of the negative feelings promoted by the contract inspector and the score for the performance are correlated, it is noticed that among those who gave the maximum score to the inspector, the number of people who express anguish indifferently is equal to the number of people who claim to have the feeling of anguish very low. Still in relation to the maximum score, what draws the most attention is the interpretation that the feeling of fear is very low (Graphic 14), followed by the feeling of being indifferent. As for the maximum score regarding the

feeling of repulsion, there is a balance between indifference and the feeling being very low. It is noteworthy that in all feelings aroused, the percentage was very low if occurrence.

Graphic 14 - Correlation between feelings of fear and attribution of score.



Source: The author, 2021.

When the data on the performance of the contract inspector during the pandemic was correlated, for those who pointed out that there were changes, 15 interviewees, the majority claimed that the changes were for much better or better. Among those who claimed that there was no change in behavior, 42 interviewees, some claimed that even if there was no change, they went for better or much better (Graphic 15).

Graphic 15 - Correlation between changes or not in the performance of the contract inspector and the quality of the change during the pandemic.



Source: The author, 2021.

From this item, it can be inferred that even though there were no changes in fiscal behavior, during the pandemic, the actions taken by the inspector were considered satisfactory for service providers.

V. FINAL CONSIDERATIONS

It is possible to point out, after the exposure of the research results, that the figure of the contract inspector before the service providers is recognized, and that although many claims to have notions about the activities performed, when directly confronted with the responsibilities of the same, there is a dissonance. It was possible to infer that the inspector has a very good performance and that he still transmits security and confidence in the decisions about the inspected activities. They also point out that this generates a low level of

negative feelings and interference in the daily life of outsourced service providers.

It appears from these statements that, before outsourced service providers, the function of contract inspector is an active server, knowledgeable of all the processes that surround it and, therefore, has credibility.

However, when some specific details are observed in relation to the performance of activities, it is clear that improvements can be implemented, such as, for example, the creation of a Welcome, Integration and Good Practices Manual, which presents to outsourced service providers the instruments used by the inspector for his measurements, the functions of the responsible representative of the company and his respective competences, as well as rules of work safety and health, personal presentation and professional conduct.

To the top managers of the Institution, it is recommended to create competency-based management instruments, capable of identifying, with the active body of employees, professionals who have an adequate profile for inspection. The possibility of creating advantages, whether financial or meritocratic, is also foreshadowed by those who, within the institutional scope, are assigned to exercise the function in a cumulative manner to their daily work activities, thus minimizing, the burden of inspection.

ACKNOWLEDGEMENTS

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Flood Disaster Risk Assessment Based on Fuzzy Information Optimization Method in Limbe Town, Cameroon

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Keywords— Flood risk; Flood damage; Fuzzy information optimization; Cameroon.

Abstract— Cameroon like many other countries is a victim of the negative externalities of flood disaster. The alarming record register by the report of the international Emergency disaster database discloses the undesirable consequences of natural disaster on the economy of the country. Flood risk has escalated in Limbe Town as a result of the rising, industrial development, and urbanization. Although there has been a substantial rise in flood risk assessment studies in Limbe, there still exist problem as to what concern flood risk assessment in the city of Limbe. Due to these issues, we gathered and analyzed flood damage data from the Limbe urban council disaster database from 1990 to 2018 to determine the flood risk in different Limbe neighborhoods. To evaluate disaster data, the study proposes a new method called fuzzy information optimization. Our results demonstrate that Down Beach, Church Street, and Mile two localities located at the south of Limbe are the most vulnerable areas, with the highest risk of flood, followed by New town, Clerk's quarter, Njengelle Quarters, and Gardenswhile limbe camp, Bota, and mile one have the lowest flood risk. The fuzzy information optimization approach makes risk information available to decision-makers and planners, allowing them to identify areas as high-risk flood, moderate-risk flood, or low-risk flood, and implement flood risk management at the national and local levels. The first tool used to assess flood disaster risk in Limbe was fuzzy information optimization, which can also be used to assess flood disaster risk in other countries and regions.

I. INTRODUCTION

The earth's surface is referred to as a planet of life due to its infinite flora and fauna, the latter is also seen as a fertile environment of natural calamity, broadly known as natural disaster and natural hazard. According to (Petrucchi, 2012) There is a difference between a natural hazard and a natural disaster. Meanwhile the former can be due to a geographical, atmospheric, and hydrological occasion, which can take the form of a tsunami, landslide, windstorm, earthquake, flood, or drought, which have the possibility of causing injuries or damages. The latter is the occurrence of a catastrophic incident that has a detrimental effect on

society, causing destruction, chaos, and casualties, and has the potential to place the affected zone in a dire situation, forcing her to rely on external assistance to work properly. Also, from the aforementioned mentioned forms of natural disaster, (Chen, Zhou, Zhang, Du, & Zhou, 2015) consider flooding as the most dangerous due to its capacity of causing great loss in terms of human life and properties leading to a drastic effect on the economy. Following the finding of the author, According to the International Emergency Disaster Database, there were nearly 12547 natural disasters worldwide between 1900 and 2017, resulting in 22,989,400 deaths. Couple with an economic

loss estimated at 290.28 billions Dollar. Likewise, among these disasters, flood disasters rank top, leading to numerous deaths and loss of properties in the society, as an illustration, in 2001, due to heavy rainfall. The City of Limbe in Cameroon led to a combination of flood and landslide causing more than 32 landslides scar, several tensional cracks, 154 houses were destroyed rendering nearly 233 people homeless, 93 people dead and About 197 people registered related to post-illness and wound at the Limbe District Hospital alone (Ndille & Belle, 2014). Likewise Flooding is caused by groundwater levels, hill slide runoff from sudden storms, and river flooding. (Saral, Özcan, & Musaoglu, 2010). Extreme rainfall events combined with rising sea levels, as a result of climate change, are likely to increase the frequency and intensity of flood disaster damage. Furthermore, global flood exposure is expected to triple by 2050, owing to rising population and economic assets in flood-prone zones, which are typically seen as economically desirable areas due to their developed nature.(Jongman, Ward, & Aerts, 2012). Regardless of the huge investment in the riverine and coastal areas, faced with flood disasters, this seems very inadequate(Bubeck, Botzen, Kreibich, Aerts, & Sciences, 2012). no matter the spatial policies planning set to mitigate flood risk, this situation is also worsened by the settlement of people near flood-prone areas like low-lying areas and coastal areas(Aerts, Barnard, et al., 2018).Flood risk assessment is the calculation of the overall adverse effects of flooding for a specific region, according to (Tingsanchai and Karim, 2015). It is affected by a variety of factors, including the depth of flooding, the length of flooding, the velocity of flood waves, and the rate at which water levels rise. Many African countries are prone to natural hazards, Cameroon as well is not an exception to this, worsened by the vulnerability of its rising population, resulting in the regular disaster which has a severe incidence on the economic aspect of the country. yet, Cameroon face great constraint in the implementation of the Kyoto 2005-2015 framework and that of the current Sendai framework recommendation of 2015-2030, which has as aims to mutilate natural and manmade disaster(Bang, Miles, & Gordon, 2019).

As mentioned by(Saleth & Dinar, 2004), we can underline that countries that are bounder by water bodies are fertile lands for flood disaster risk, and Cameroon is not an exception. Flood disaster risk is determined by a

combination of two factors: danger and vulnerability. The land and its uses are determined by flood hazards expressed as vulnerability. As a result, in less populated urban areas, the effects of this phenomenon can cause less damage. In urban areas, flood risks are evaluated more than in rural areas. As in urban areas, flood hazards lead to the destruction of buildings, equipment, roads, houses, and track. In Cameroon, the flood hazard record dated in 1980, and since then the country has witnessed a drastic series of flood hazards(Tchindjang, Amougou, Abossolo, Bessoh Bell, & Africa, 2012).

Limbe Town is located on Cameroon's coast, in the fako division, specifically in the country's southwest region. She has an estimated population of 120,000 people within a total surface area of 545km². The city's previous characteristics explain why it has one of Cameroon's highest population densities of 220 people per square kilometer. This important number of people can be justified mainly by socio-economic reasons such as the presence of the CDC plantation which offers jobs to the population and the presence of beaches couple with a botanic garden in Limbe. Likewise, the city of Limbe renders her a fruitful zone of flood disaster risk. The city is dominated by a low-lying coastal plain that rises to a chain of horseshoe-shaped hills with varying degrees of steepness toward the northeast and east, the highest point reaching 362 meters above sea level (Njabe and Fobang 2006). In addition to this, Limbe is 10 miles away from Debundscha, where the latter is considered to be the second the wettest place after Cherrapunji in India. This explains why the city experiences constant heavy torrential rainfall in the rainy season which runs from the month of October, and it equally witnesses the highest average monthly precipitation in the month of June, July, and August in Cameroon of about 700mm (Ndille & Belle, 2014). Couple with this, the city is also blessed with small streams that flow into larger drainage beds, and the latter flows into main rivers and eventually ends their course into the Atlantic Ocean. During these heavy rainfalls, it is important to underline that these rivers overflow their banks due to the severity of the precipitation in the rainy season and causes flooding. This situation is also favor mainly due to the absence of proper conceived drainage channels throughout the city. This exposes the Settlement that is located along the coast of Limbe.

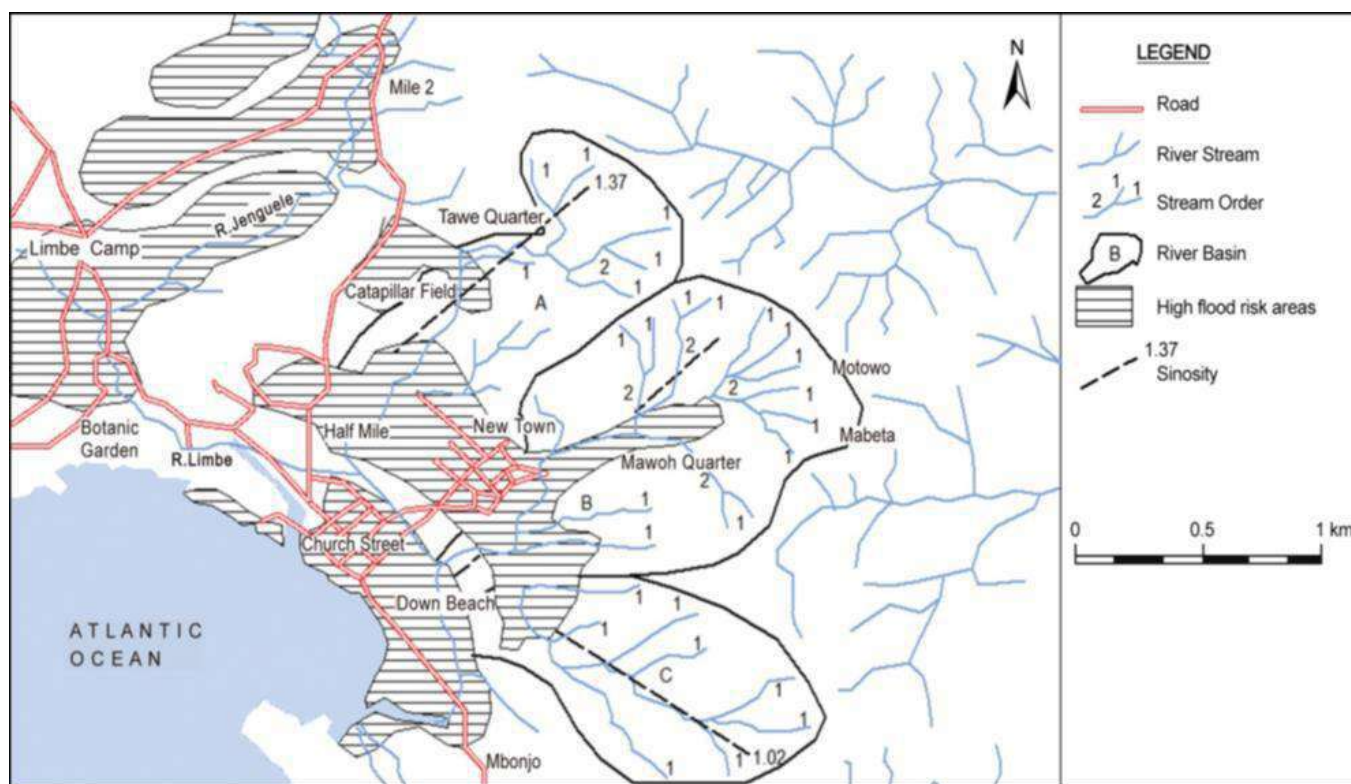


Fig.1 Geographical location of Limbe

II. LITERATURE REVIEW

Following the increasing occurrence of flood disasters worldwide, the literature has outlined a panoply of methods aimed at assessing the later flood. According to the literature and thanks to the work of (Ali, Bajracharya, Koirala, & Biotechnology, 2016) flood disaster risk can be assessed following either a hydrological, meteorological, or socioeconomic perspective. Base on the GIS and the risk assessment theory (Wu et al., 2015) developed a model to assess flood risk disaster, They designed an index system based on natural disaster risk and economic society vulnerability. Furthermore, they add two indices, reservoir storage modulus, and flood retention basin modulus, to aid in the analysis of human interaction power in flood hazard indexes. In addition, (Shi, Zhai et al. 2019) used the FDRA index to assess the probability and effects of flood disasters in Xiamen, which is one of the cities in China with the most severe flood disasters. They based their studies on the risk theory, and their findings show that Xiamen's flooding and drainage control capacities are insufficient, resulting in high flood risk. Apart from socioeconomic negatives externalities of flood to an area, (Garrote, Diez-Herrero, Escudero, & García, 2020) emphasize the negatives impacts which flood has on the cultural aspect of Castile and Legion regions in Spain, which is composed of 2155 cultural heritages. Likewise, (Aerts, Botzen, et al., 2018) carried out a study which was

aimed at disclosing the role of human behavior of flood in their environment and how the latter can also be used in assessing flood. One of the most difficult issues for researchers in quantitative risk assessment is determining how to resolve the position of individual expectations of risk-reducing activity and how these factors affect agent decisions to take flood-prevention steps (Kleindorfer, Kunreuther et al. 1993). Also, to reinforce the accuracy of forecast data related to flood disaster risk, (Escuder-Bueno et al., 2012) base on the SUFRI project which analyses flood risk in two dimensions. The first dimension raises awareness for pluvial and river flooding risk assessments in urban areas to educate and inform policymakers, while the second dimension investigates human risk perception by disseminating information with a social context and analyzing trends in how people perceive floods. The study reveals that the application of these two dimensions or methodologies appears to be a key tool for the decision-maker in their role of assessing flood disaster risk. Still in the same vein, (Pistrika, Tsakiris, & Nalbantis, 2014) established a methodology to assist water managers and authorities in developing rational flood-prevention plans. This is possible following a three steps assessment approach to assess flood disaster risk, where the first step involves analyzing hazard which incorporate both probabilities occurrence couple with anticipating potential damages; The second step is to assess flood vulnerability

in flood-prone areas, and the third and final step is to assess flood risk.

Equally, to assess physical and socioeconomic vulnerability, where the former comprise of susceptibility and exposure whilst the latter is based on quantitative and qualitative indicators, (Cutter, 1996) developed an index that assesses flood risk into four dimensions which are high, moderate, moderately low and low. This index mention can categorize flood risk in four dimensions and it acts as a key tool to handle flood disaster risk. (Bang et al., 2019), faced with the alarming nature of natural and manmade disaster risk in Cameroon. despite the various engagement of the country to an international framework such as the Sendai frameworks and recommendations with the aim at promoting RRD in developing countries, Due to resistance in communication, coordination of DRR operations, availability of services, foreign assistance, formulation of DRR plans and policies, and integration into sustainable development plans, the country still faces some significant constraints. Equally, (MOFFO, TONYE, & Maurice, 2013), alert the devastating nature of flood in the city of Douala partly due to the heavy average rainfall of 4000mm per year during these two past decades, carry on a study based on the methodology of (Beven & Wood, 1983) which delineated wetlands and extract flood zones. Also, the literature focuses on the case of African countries which are also fertile zones for flood disaster risk but the inadequate database related to past flooding observation and insufficient studies on the issue in Africa expose the latter to high risk of flood disaster, which has heavy negatives consequences as point out by (Conway, 2009). This situation can justify the occurrence of flood disasters and the inefficiency of African authorities in their strategies of flood disaster risk reduction.

Nevertheless, (Talha, Maanan, Atika, Rhinane, & Sciences, 2019) faced with an alarming number of flood disaster records in Africa and in the Western part of Morocco couple with huge direct and indirect damage in terms of properties and human life which has a great incidence on the economy.

III. METHODOLOGY

To assess flood risk in Limbe, this study uses a fuzzy information optimization approach making use of data from the national archives in Limbe. Weights for flood damage attributes are generated using the AHP. After that, the weighting result is combined with the fuzzy information optimization method to rate the flood risk of different Limbe neighborhoods.

3.1 Data used

The researcher obtained flood damage data from the National Archives in Buea (NAB), the National Archives in Yaounde (NAY), the Ministry of Territorial Administration and Decentralization (MINATD), and the Limbe district, which is located in the Limbe province of Cameroon (former urban council). The Limbe Urban Council data consist of different flood and storm events of four different years. The database contains a large set of direct flood data in ten categories; Maximum annual precipitation, Drainage density, Nature of topography, Soil texture, Population in the unit area, Reported health cases, Building destroy, Roads and bridge damage, Electricity/water installation damage, Gross domestic product (USD). These 10 categories are quantified.

3.2 Data processing

The data has been compiled at the Limbe urban council from different localities that are: Lumpsum, Mile Two, Church Street, New Town, Lower Cassava, Clerk's Quarter, Down Beach, and Manga William's, Motowoh Quarters, Dockyard, Mawoh Quarters, Bimbila, Limbe1, Etome, and Mokunda. The flood damage data used for analysis are data from different localities in the Limbe town for four different years respectively (1990, 2000, 2001, and 2007). with ten variables of Maximum annual precipitation, Drainage density, Nature of topography, Soil texture, Population in the unit area, Reported health cases, Building destroys, Road and bridge damage, Electricity/water installation damage, Gross domestic product (USD). Each year an observation is carried out for each of these locality making a total of 1400 observations.

3.3 Flood risk assessment using the Fuzzy Information Optimization Method

The Fuzzy Information Optimization Method (FOP) was used in this study to assess flood disaster risk. This approach employs fuzzy mathematical theory to create an overall assessment of complex problems that are influenced by several factors. This approach is used to determine flood risk to remove any ambiguity or confusion that might occur during the assessment process. Furthermore, using fuzzy set theory and fuzzy logic, fop converts qualitative evaluation into quantitative evaluation, allowing it to provide or obtain precise evaluation results. Fuzzification, fuzzy inference, and defuzzification are the three steps in a fuzzy scheme or solution. Fuzzification is the means of transforming qualitative to quantitative values in a proposal using the membership function. The membership function and control rules are combined to produce variables or indexes in the fuzzy inference process. Defuzzification is the process of combining the outcomes of each rule to generate the final result. In this study, the three processes above Fuzzy

classification, membership features, and comprehensive evaluation all correspond to each other.

3.3.1 Fuzzy Classification

When FOP was used to determine flood risk, it was divided into five categories: very low, low, moderate, high, and very high, respectively. standard deviation statistics and the value of each raster layer were used to determine

the level interval. The interval grade value (Δ) of the raster data fuzzy subset is determined by the lower value of the standard deviation difference. Each raster data set is graded on the same interval value. There are five interval points in each.

D1, D2, D3, D4, D5 (Table 1).

EACH FACTOR'S INTERVAL VALUE

TABLE 1

Kind of index	Δ	D ₁	D ₂	D ₃	D ₄	D ₅
Maximum annual Precipitation (m/m ²)	70	150	220	290	360	430
Drainage density (m/m ²)	0.0010	0.006	0.0016	0.0026	0.0036	0.0046
Nature of topography	0.34	1.20	1.54	1.88	2.22	2.56
Soil texture	5	8	13	18	23	28
Population per unit area /10 ⁵ m ²)	2.65	1.20	3.85	6.15	9.15	11.80
Reported health cases	19	20	39	58	77	96
Building destroyed	16	83	99	115	131	147
Roads and bridge damage	7	5	12	19	26	33
Electricity/water installation damage	15	8	23	38	53	68
Gross domestic product (USD)	2218	1120	3338	5556	7774	9992

3.3.2 Membership function

The fuzzy set is used to quantize fuzziness through membership functions (MFs), it helps to eliminate the uncertainty while obtaining a fuzzy evaluation matrix. That is the determination of suitable membership function can be critical for risk assessment results. Many types of

membership functions exist such as Waveforms such as Gaussian, bell-shaped, sigmoidal, triangular, trapezoidal, and so on. Since floods are short-duration events, the trapezoidal and triangle waveforms must be chosen to describe the piecewise functions.

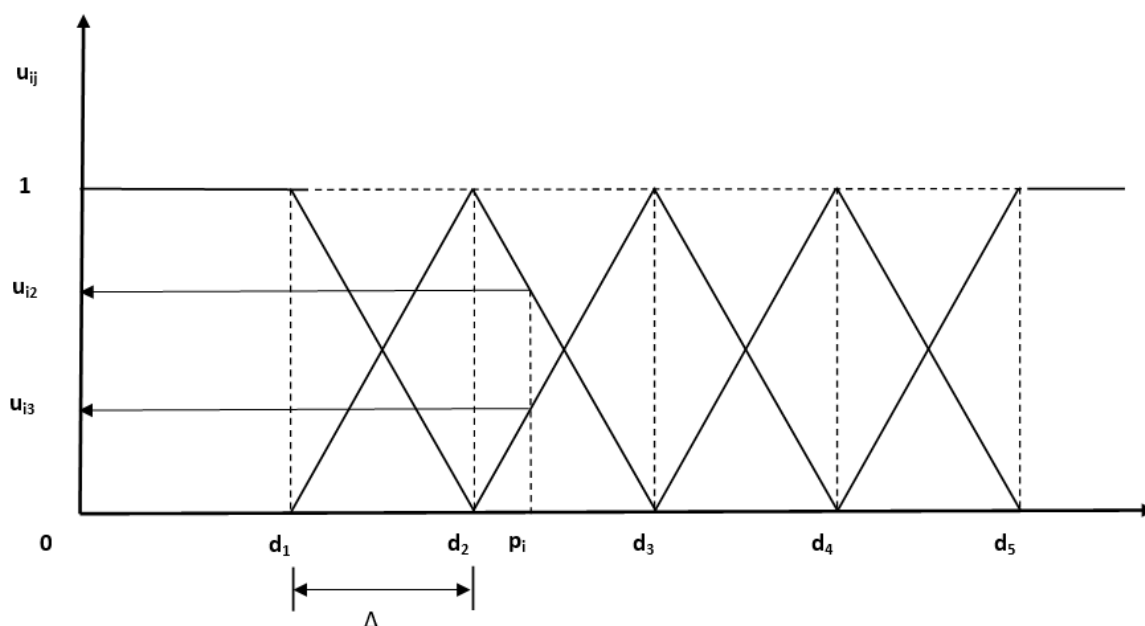


Fig.2: Fuzzy set of membership functions

$i = 1, 2, \dots, 10$; $j = 1, 2, 3, 4, 5$. P_i represents the raster data of index i . In Fig 2, P_i has two levels of membership that is U_{i2} and U_{i3} .

Sets of formulas (Equation (1)- (5)) can be used to obtain the fuzzy membership function value of each factor related to the five evaluation levels.

$$u_{i1}(p_i) = \begin{cases} 1 & 0 \leq x \leq D_1 \\ \frac{D_2 - p_i}{D_2 - D_1} & D_1 < x < D_2 \\ 0 & x \geq D_2 \end{cases} \quad (1)$$

$$u_{i2}(p_i) = \begin{cases} 0 & p_i \leq D_1 \text{ or } p_i \geq D_3 \\ \frac{p_i - D_1}{D_2 - D_1} & D_1 < p_i < D_2 \\ 1 & p_i = D_2 \\ \frac{D_3 - p_i}{D_3 - D_2} & D_2 < p_i < D_3 \end{cases} \quad (2)$$

$$u_{i3}(p_i) = \begin{cases} 0 & p_i \leq D_2 \text{ or } p_i \geq D_4 \\ \frac{p_i - D_2}{D_3 - D_2} & D_2 < p_i < D_3 \\ 1 & p_i = D_3 \\ \frac{D_4 - p_i}{D_4 - D_3} & D_3 < p_i < D_4 \end{cases} \quad (3)$$

$$u_{i4}(p_i) = \begin{cases} 0 & p_i \leq D_3 \text{ or } p_i \geq D_5 \\ \frac{p_i - D_3}{D_4 - D_3} & D_3 < p_i < D_4 \\ 1 & p_i = D_4 \\ \frac{D_5 - p_i}{D_5 - D_4} & D_4 < p_i < D_5 \end{cases} \quad (4)$$

$$u_{i5}(p_i) = \begin{cases} 0 & p_i \leq D_4 \\ \frac{p_i - D_4}{D_5 - D_4} & D_4 < p_i < D_5 \\ 1 & p_i \geq D_5 \end{cases} \quad (5)$$

3.3.3 Comprehensive Evaluation

The membership values establish the evaluation matrix T .

additionally, the associated flood disaster risk indicators

$$T = \begin{bmatrix} t_{11} & t_{12} & \dots & t_{15} \\ t_{21} & t_{22} & \dots & t_{25} \\ \vdots & \vdots & \ddots & \vdots \\ t_{i1} & t_{i2} & \dots & t_{i5} \end{bmatrix} \quad (6)$$

$$t_{ij} = u_j(p_i), i = 1, 2, \dots, 10, j = 1, 2, \dots, 5.$$

Given the difficulty of assessing flood disaster risk, this paper employs raster data layers as a flood disaster risk index, resulting in the establishment of a hierarchical structure of flood disaster risk assessment indexes based on an analytic hierarchy process (AHP). The weight of ten

variables was taken into account, which are as follows: 0.3295, 0.1793, 0.0456, 0.1601, 0.0852, 0.0425, 0.0212, 0.0631, 0.0140, and 0.0072.

IV. RESULTS AND DISCUSSIONS

The flood disaster risk map was obtained for the various localities in Limbe. High-risk, medium-risk, and low-risk zones are represented on the diagram. zones of high areas are Cassava farms, Clerks Quarters, Down Beach, Lumpsum, Church Street, Mawoh Quarters, Motowoh Quarters, and Dockyard. The reason for the high-risk zone

of these areas is simply because of its location at the coastal area or areas along rivers. whereas the medium risk zones include Bimbila, Limbe1, most especially Moviokulu, Batoke, and Limbe III particularly Camps Three, Etome, Mokunda, and Limbe II Mokundange are low-risk zones. The low-risk zone is because of High Mountain and low population.

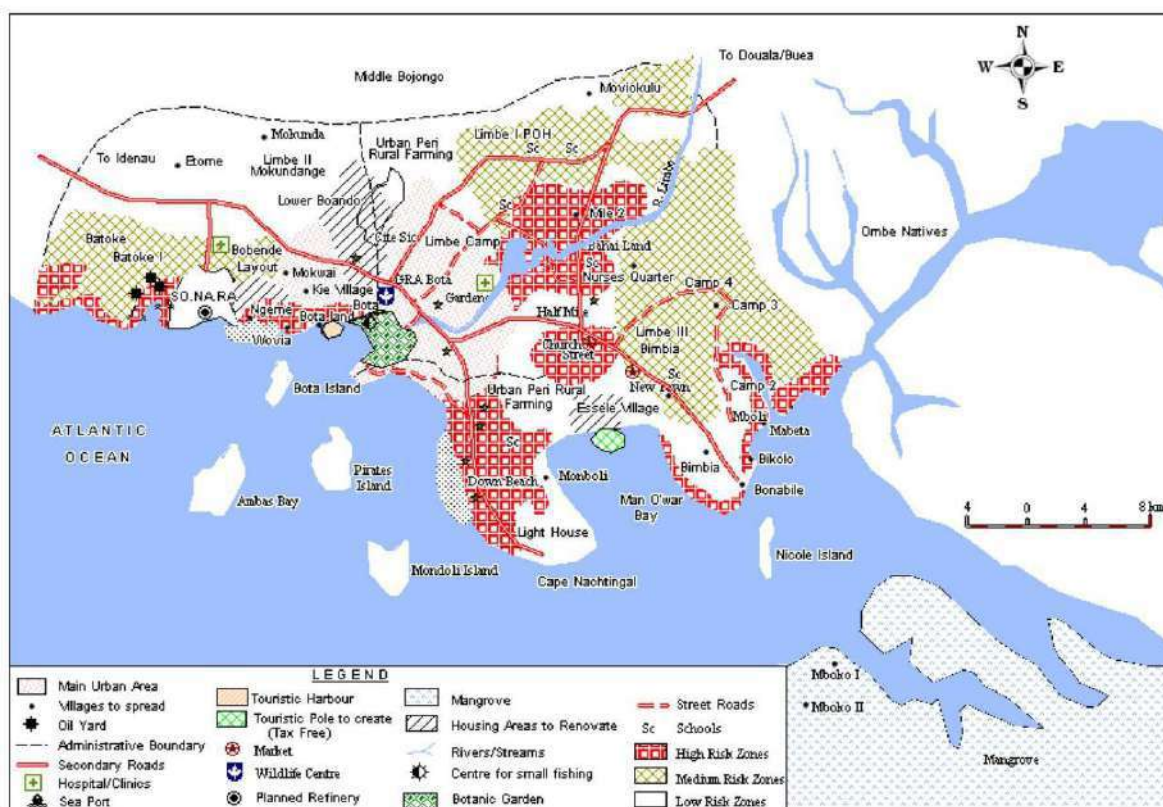


Fig. 2. Map showing the flood-affected areas in Limbe

Source: Adapted from the map of Limbe, NIC (2016)

4.1 Risks validation

Flood risk validation is the process of determining the accuracy of a risk assessment by comparing it to other data to confirm the vulnerability of

high-risk areas. Flooded areas are well considered to be high-risk areas. Based on the information and findings of this paper, we can outline the areas of high-risk and low-risk zones and their justification.

Table.2 Vulnerable Limbe Zones to flood risk

Categories of flood risk vulnerabilities	Limbe towns which are prone to flood disaster risk	Justification
Very high probability	Down Beach church street, mile two	These towns are characterized by functional plains When there is a storm, water must flow or be collected. In general, these lands are subjected to a 1 in 20 (5%) or greater annual risk of flooding or are planned to flood in a (0.1 percent) flood. Also, these towns witness permanent flooding during the peak rainy season month.
High probability vulnerability	New town, Clerk's quarter, Njengelle	These towns have a 1 in 100 or higher annual probability of river flooding (greater than 0.1 percent) or a 1 in 200 or higher annual

	Quarters, Gardens	probability of sea flooding (greater than 0.5 percent) in a given year. Similarly, these towns observed floods weekly during the last days, and floodwaters ubiquitous.
Moderate probability vulnerability	Lumpsum, cassava farm, Poto-Poto Quarter, Mahow, Mabeta new layout	These towns are characterized with 1 in 100 and 1 in 1000 probability of (1% to 0.1%) in a year of river flooding and a 0.5 percent annual risk of sea flooding (between 1 in 200 and 1 in 1000)Likewise, these towns witness monthly flooding
Low probability vulnerability	Limbe Camp, Bota, and Mile one	These towns have an annual likelihood of river or sea flooding of less than 1 in 1000 (0.1 percent), and floods occur only when storms are particularly severe.

Source: (Nguh and Anumveh, 2018)

Based on the table above Down Beach, Church Street, and mile two localities in Limbe town, flood disaster risk assessment accuracy is invalidated. When a fuzzy information optimization approach is used to evaluate risk, it can reduce a variety of uncertainties by quantifying risks arising from human experience. The FOP approach is focused on fuzzy set and fuzzy logic theories, which transform uncertainty into certainty in risk assessment. In the fuzzy information optimization approach, the outcome of flood risk is determined by the grade interval of various indicators as well as the waveform of the membership function. In addition, the grade interval is divided based on the properties of each indicator's value as well as the current state of the study location.

However, it should be noted that in this paper, we used the risk conceptual structure suggested by the United Nations when conducting flood risk assessment research using the fuzzy information optimization approach. This approach aims to choose a more accurate and acceptable risk indicator while also acknowledging the effect of natural and socioeconomic factors on flood risk without affecting the final risk area result.

4.2. Flood Risk Reduction

The aim of a flood risk assessment is to recognize areas that are at risk of flooding and to develop flood management strategies to reduce flood damage.. We suggest implementing a series of flood control and mitigation steps in high-risk areas of Limbe town based on the FOP's risk-zoning map and field investigation. These activities include engineering and non-engineering measures

4.2.1 Engineering Measures

Engineering steps apply to any location or structure that is used to avoid, divert, store, or drain floodwater. After conducting a field survey in the various Limbe Town neighborhoods, engineering measures were requested.

(1) Upgrading flood protection structures: Because of the flat terrain and low drainage, flood control or an artificial levee, as well as the building of a hydrological system network, has been established along the riverine. Moreover, Limbe camp, Bota, and Mile one have comparatively low fortification criteria since they are located in mountainous areas in Limbe, can withstand floods for a longer period. This can therefore be prevented by removing dangerous water dam projects.

(2) Dredging of the channel in highly aggressive areas, sedimentary section: The hydrodynamic environment weakens as rivers flow out of the mountains and into the plains due to the widening of the river's channel. Because of sediment aggregation, the riverbed rises, increasing the likelihood of flooding. As a result, routine strategic dredging is essential to restore the natural state of aggradation.

4.2.2 Non-Engineering Measures

There are a variety of regulations, rules, administrative management, and technological options for reducing flood disaster losses in floodplains. In this study, various measures are proposed with the actual situation of our study area.

(1) Rules regarding land use planning: The land use in the study area, as well as the flood plain management strategy, must be carefully designed. Zones with a high chance of being identified as high-risk zones should be designated for low occupancy. Additionally, industrial and residential land should be designed to be used in high-altitude areas, with urban development ensuring that the river channels are preserved at a reasonable area.

(2) Putting in place flood risk insurance: Flood insurance is an effective tool for flood risk management in floodplains. Insurance, on the other hand, is a social-economic aid for flood-related property loss. As a result, we propose that the government establish a flood insurance program for residents in high-risk areas.

(3) Flood resistance capacity building construction of flood resistance capability necessitates real-time and reliable hydrological tracking, forecasting, and early warning systems. Furthermore, the community can practice evacuation exercises regularly to boost flood awareness and disaster preparedness. Each of these measures will help minimize the likelihood of flooding, as well as the number of people who die and the amount of money lost.

V. CONCLUSION

Over the last few decades, climate change and rapid urbanization have increased the risk of flooding in metropolitan areas. Flood risk assessment is important because it aids in the identification of high-risk areas for potential management.

In this study, a fuzzy information optimization approach based on the weight of selected variables was proposed and applied to risk assessment in Limbe's various quarters. Due to the existence of several rivers, medium, high, and very high-risk zones were primarily found along the coast, while low and very low-risk zones were found in the Limbe town's plateau and mountainous regions, according to research. The Limbe municipalities, on the other hand, proposed mitigation strategies for high and very high-risk areas, considering the field investigations as well. This is important because it aids in the reduction of urban disasters, reducing fatalities and economic losses.

The fuzzy information optimization approach is based on fuzzy set and fuzzy logic theory, which helps risk management procedures minimize or remove fuzziness and ambiguity. The waveform of the membership function, which is calculated by the value of each indicator and flood event characteristics, determines the performance of risk. When using the fuzzy information optimization approach in conjunction with a particular collection of risk indicators, a risk zoning map is created, which can be regarded as the risk map of any study area. The collection and accuracy of data indicators will need to be refined in future studies or analyses.

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Risk Implementation Aid model for Technical factors in Developing Countries' informal SME

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Keywords— Risk Implementation Aid, Integration knowledge, Integrated Risks Management, Informal Small & Medium Enterprise, , Technical factors.

Abstract— The implementation of risk management plays critical role in an organization. The majority of SMEs find difficult to establish it in their organization. As important tools, the risk management factors can be either social or technical. And since most of these informal SMEs focus more on the technical engineering aspect of the society, this paper looking to find the technical factors that could positively influence the implementation of risk management. The purpose of this paper is the development of a Risk Implementation Aid Model with critical factors and constructs to help the process of implementing risk management. In general, the research is looking to answer our research question: “What are the technical factors for the successful implementation of RM in informal SME?”

I. INTRODUCTION

Risk management has historically been conducted in silos, in the sense that insurance risk, technical risk, financial risk, organizational risk, etc., have mostly been handled independently of one another and on department charts. This way of managing risks in silos has shown its limits, as evidenced by the numerous debacles we witnessed in the last two decades. As an example, we cite the recall of Toyota cars justified by defective accelerator pedals and the brake problem on the Prius. These difficulties are accompanied by considerable financial costs, loss of shareholder value, and worse still, severe damage to the firm's reputation.

Such an environment characterized by an increase in risks whose consequences go beyond what can be anticipated requires that managers adopt a global perspective on managing risks such as Enterprise Risk Management (ERM) (Rao, 2007). Over the years, we have seen the development of a new direction of risk management (ERM), called “integrated risk management,” in the sense that it is practiced throughout the enterprise. Already in 2003, more than 30 firms formalized ERM by designate a

Chief Risk Officer (CRO) to lead their ERM program (Liebenberg & Hoyt, 2003). The first organizations to adopt ERM quickly realized that investment, growth, innovation, and technical changes are contributing significantly to increasing complexity as well as the diversity of risks (Rao, 2007). Indeed, according to Ernst & Young's Board Members on Risk report, which dates from 2006, 72% of members believe that the total risk to which firms are exposed has increased by 41% in the last two or three years. As a result, the ad hoc or informal way of managing risks now seems unacceptable to them. These members also accept that in view of the changing market climate, the approaches available to them to date were insufficient.

In addition, the need to comply with certain regulations, has led companies in the financial sector to take into consideration not only different categories of risks, but also the way whose multiple risks are managed and controlled throughout the organization. The ERM is part of this movement.

Unlike traditional management, ERM makes it possible to manage a fairly large range of risks in an optimized way,

on a company-wide basis. On the other hand, there is a consensus that ERM increases risk awareness, which, in turn, promotes innovative strategic and operational decisions ([Hoyt & Liebenberg, 2011](#)). A comparison between conventional risk management and ERM has been made.

In 1995 the EIU and Andersen, A. hey develop a comparison of conventional risk management with ERM as follows:

Conventional risk management:

(1) Fragmented: separate risk department/function manager; accounting; auditor, mainly concerned with the internal audit.

(2) Ad hoc: risk mitigation is carried out when administrators feel there is a need to do so.

(3) Narrowly focused: mainly deductible risk and investment risk

Enterprise Risk Management:

(1) Integrated: risk management organized with senior supervision; everyone in the company considers risk management as part of their business model

(2) Continuous: Continuing risk management cycle

(3) Broadly focused: All market challenges and opportunities are taken into account

II. BENEFITS ASSOCIATES WITH ERM

usually refers to the mechanism by which a firm anticipates, avoids, and reacts to the challenges associated with organizational goals ([Monahan, 2008](#)). Through this process, the firm proactively determines the appropriate risk types and levels for achieving its objective ([Crouhy, Galai, & Mark, 2006](#)). As with danger in general, the ERM is subject to many other interpretations aside from these concepts. Below, we reproduce the ones most commonly seen in the literature:

We can group these benefits into three categories:

(1) Benefits relating to governance and compliance aspects: As we mentioned earlier, some regulations, such as Sarbanes-Oxley and the Basel Committee on Supervision, require integrated risk management and consideration. In view of this, the ERM appears to be a very appropriate methodology. In fact, through the ERM, the committee of directors responsible for supervising management activities has not only exhaustive information relating to risk-taking, but also a methodology which enables it to better control them. This exhaustive information also facilitates due diligence on compliance with certain internal and external regulatory requirements.

(2) Benefits associated with creating value, competitive advantage, and financial performance: One of the recognized benefits of ERM is its ability to reduce income volatility and, therefore, create value ([Lam, 2014](#)) ([Feldblum, 2001](#)). In addition, given its organizational scope and integrated structure, the ERM participates in the deployment of the strategy in the organization. As such, it is likely to give the organization a competitive advantage. Ultimately, these operational and strategic advantages will translate into improved organizational performance ([Liebenberg & Hoyt, 2003](#)) ([Coopers, 2004](#)).

(3) Benefits that we call fundamentals: According to Bailey, Bloom, and Hida, ERM provides a certain number of advantages, including those allowing management to understand how risks are managed through the daily activities of the firm, to provide a perspective on a scale of the company according to the risk The company profile as well as control mechanisms by aggregating and integrating a set of key information and, ultimately, proactively identifying and assess all significant categories of risk, not to mention how they affect the organization's business objectives ([Bailey, Bloom, & Hida, 2004](#)) ([Hoyt & Liebenberg, 2011](#)).

In short, ERM offers a holistic and detailed view of the risks facing the company. Companies are using the ERM to ([Alvinussen & Jankensgard, 2009](#)): create value ([Beasley, Branson, & Hancock, 2009](#); [Beasley, Frigo, & Litman, 2007](#); [Simkins, 2008](#); [Viscelli, Beasley, & Hermanson, 2016](#)); lower the cost of insurance ([Li & Huang, 2019](#); [Shad, Lai, Fatt, Klemeš, & Bokhari, 2019](#); [Shan, Xin, LI, & FENG, 2010](#)); Improving efficiency ([Gordon, Loeb, & Tseng, 2009](#)); define the strategy to be adopted concerning the risks in place ([Banham, 2004](#)); support the development of new products ([Gurau & Ranchhod, 2007](#)); know the origin of the risks and the degree of exposure to them ([Merkley, 2001](#)).

On a more empirical basis, Fraser et al. ranked the benefits of MRE in decreasing order of importance (Table1) ([Fraser, Schoening-Thiessen, & Simkins, 2008](#)).

Table1 the benefits of ERM

Enterprise Risk Management Benefits	%Responding of firms (38)
Better understanding and management of risk (including the integrated view)	44.7
Improve corporate governance or meet board requirement	18.4
Assist in allocation of resources	15.8

Effective decision-making	15.8
Minimize surprises	13.2
Improve risk reporting and risk controls	10.5
Achieve financial stability or better risk-adjusted returns	10.5
Improve credit rating	10.5
compliance	10.5
Enhance shareholder or firm value	7.9
Create a risk-aware culture	7.9
Best practices or achieve excellence	5.3
Support business or strategic plan	5.3

Source: Fraser, J., Schoening-Thiessen, K., and Simkins, B. (2008). Who Reads What Most Often? A Survey of Enterprise Risk Management Literature Read by Risk Executives. *Journal of Applied Finance*.

III. RM IMPLEMENTATION AS A TECHNICAL CHALLENGE

Our analysis focuses on a relatively researched feature of ERM and its application as well as key factors to successfully implementing ERM.

Implementation in many respects has been defined. It could refer to a constantly dynamic process of mutual adaptation between innovation and their environment in order to rectify the usual errors between innovation and the environment(Leonard-Barton & Deschamps, 1988; Leonard, 2011). It may also refer to a process that begins with an initial idea for a new approach or methodology and the changes it transmits and ends when the new practice has succeeded in integrating it into the work systems of the organization(Krcmar & Lucas Jr, 1991). By synthesizing these ideas, we understand implementation as a process through which target users embrace, accept and revise innovation into their regular work processes(Kwon & Zmud, 1987).

Many studies have analyzed different aspects of ERM implementation in this respect. The link between ERM implementation and firm value is one such aspect, particularly the degree to which the level of ERM execution has a positive effect on the value of coted companies. For example, some studies show that the implementation of ERM increases overall solid value irrespective of particular users in the industry(Bertinetti, Cavezzali, & Gardenal, 2013), and these companies see implementation of ERM as a strategic enterprise initiative rather than a requirement for compliance(Waweru &

Kisaka, 2012). Factors related to the implementation of ERM are also of interest. Research on this subject aims to explain why some organizations respond by implementing ERM to changing risk profiles while others do not. On this basis Beasley, Clune & Hermanson concluded that the implementation phase is positive in terms of the presence of a chief corporate governors (chief risk officer) and the independence of the board, the apparent support of the CEO and CFO for ERM, the presence of an auditor of big four and their size in banking, education, and operations(Beasley, Clune, & Hermanson, 2005). The appointing of a Chief Risk Officer and the level of implementation of the ERM by Waweru and Kisaka, find substantial links, however, contrary to expectations, between ERM implementation level and the different variables such as the market, the independence and growth rates of the Board of Directors(Waweru & Kisaka, 2012). Likewise, it seems that Desender has a considerable impact on the CEO's role on the ERM, but that the board's freedom alone is not enough to lead to higher ERM levels(Desender, 2011). The independence of the Board only depends significantly on ERM if companies do not have the duality of CEO, as companies with an independent Board and no CEO duality have the highest level of ERM.

More recently, the focus of research has been on how organizations implement ERM. For example, Altuntas, Berry-Stölzle and Hoyt review the degree to which ERM is implemented by German property liability insurance firms with premium payments over EUR 40 million, including the application sequence of this emerging risk management approach(Altuntas, Berry-Stölzle, & Hoyt, 2011).

Though careful, these studies do not catch the complexities of real implementing ERMs in companies and ignore organizational characteristics which can influence the effectiveness of implementing ERMs. Their questions about the need for ERM incorporation and their readiness and capacity to contribute to this dynamic effort, especially, are not taken into account by social actors within the organisation. Furthermore, no research has consistently suggested conditions essential to implementing the ERM.

Some ERM execution actions have been published in trade and business journals, and while the guidance is helpful, its theoretical basis remains uncertain, leaving doubts as to its trustworthiness and validity. Theoretical systems would then clarify how to apply ERM effectively. These frameworks are important for examining both the technical and social aspects of the implementing of ERM and for questioning the assumption that an ERM model is

easily integrated into the work systems of an organization if risk appetite is well defined and limits and monitoring processes exist.

Actually, the key point is not that there is no use for the existing centralized risk management body with its principles, methodologies and methods, but that a more managerial approach is required to enrich and broaden ERM beyond tight financial perspective and to more closely link its application to the challenges posed by management practice.

ERM performance can be a dynamic and complex undertaking since it entails improvements in many organizational areas, such as business processes or work procedures, requiring coordination between functional units, including a variety of organization-related problems. With a holistic approach, we can conceptualize problems relating to the implementation of the ERM as a whole—that is, the identification of the ERM functions and its characteristics, the identification of links between these functions and the complexities of ERM-related integrated risk management. In particular, ERM is best seen as a social and technological structure, namely a network of individuals, instruments, records, and business routines ([Akrich, Bijker, & Law, 1992](#); [Kling & Scacchi, 1982](#)).

IV. METHODOLOGY AND CONTEXT

This paper aims to defining the success technical factors for implementing the ERM. To this end, we first take a look at the current situation of risk management in developing countries' medium-sized enterprises, which lead us to theoretical perspective that build our theoretical framework, a mutual adaptation on technical perspective and the perspective of dynamic capacities.

The technical perspective was used to capture the systemic dimensions of ERM. ERM is a systemic approach to managing organizational risks. Therefore, the system approach seems best suited. This approach makes it possible to conceptualize the challenges associated with the implementation of the ERM as a whole in the sense of identifying the elements and their attributes, determining the relationships between the elements, and, finally, taking into account the dynamics of management. of the risks recommended by the ERM. More specifically, the technical perspective makes it possible to understand the ERM as being a technical system.

The perspective of mutual adaptation allowed for the effects of mutual structuring between the ERM, and the organizational structure has to be taken into account. In addition, the implementation of the ERM needs a mutual

adaptation between the organizational context and the ERM, according to which the architectural nature of the processes and that of the ERM framework are effectively coupled in order to fully incorporate the implementation process.

Finally, the perspective on dynamic capacities has made it possible to recognize that implementing enterprise risk management compels a significant organizational resource and the coordination and integration of the various functions of the organization. As such, the organizational changes associated with implementing the ERM are complex. Specific attention must also be paid to the organization's diverse capacities if the successful implementation of ERM is to succeed.

The theoretical framework, as described, has led us to break down our general research question into more specific questions. The arguments from these theories, were able to formulate provisional answers or research hypotheses.

V. THEORETICAL PERSPECTIVE ON ADAPTATION

Regarding risk management, the enterprise risk management system is innovation. Innovation can be characterized according to two dimensions, namely its impact on administrative or technical processes and the relative weight of technological and organizational components. Taking into account only the first dimension, Swanson establishes a typology comprising three classes of innovation: innovation of types I, II, and III ([Swanson, 1994: 2020](#)).

Type I innovation is an innovation that takes place within and is confined to an organizational function such as accounting, marketing, or information technology. This type of innovation can be focused either on administrative tasks or on technical tasks. In both cases, the integration of this innovation results in increasing the efficiency and effectiveness of the organizational function.

Type II innovation involves using innovation to improve the organization's administrative processes. Technologies that support the production chain of goods and services are not affected. The introduction of computerized accounting systems and the adoption of groupware, for example, is one such innovation ([Chatterjee, Grewal, & Sambamurthy, 2002](#); [Zhang, van Donk, & Jayaram, 2020](#)). Despite being focused on administrative aspects, Type II innovation is probably going to impact the processes of the business. The integration of this type of innovation results in increasing the productivity of

administrative functions and having an impact on operational processes.

Type III innovation consists of integrating innovation in terms of products or services into the technological infrastructure. Thus, business management in general is affected. So the whole organization is affected, and innovation can give early adopters competitive advantages. The introduction of online reservation systems by airlines from the 1960s, and that of material requirements planning systems (MRP) in the 1950s and 1960s was a type III innovation (Copeland & McKenney, 1988; Das, 2019). So the overall planning and execution of the organization are affected when incorporating this type of innovation.

On the basis of the above, we can legitimately qualify the ERM as a type III innovation, given its holistic and global nature.

Given the systemic nature of ERM, its implementation can prove complex beyond problems of communications or language. Indeed, the ERM constitutes both a technical and administrative innovation. Therefore, the interaction between operational and administrative changes can be a huge challenge. More intuitively, an ERM development and implementation project could be conceived in three phases. In the first phase, the functional processes are analyzed and reconfigured to form a process architecture following the organization's value chain. In the second phase, the specifications of the ERM system are defined, then it is developed. In a third and final phase, ERM is implemented that is to say, integrated into the organizational processes.

Despite the logic of the approach, it can lead to misalignments or hiatuses between the organizational context and innovation (Hsueh, Bretschneider, Stritch, & Darnall, 2020; Leonard-Barton & Deschamps, 1988). This occurs due to the challenge of establishing ERM specifications from the first step in the process and also due to the fact that the organization and its content on the ERM system can shift along the course of the project (Jacobson, Booch, & Rumbaugh, 1999). This implies that innovation such as ERM must be carefully integrated in a manner that encourages step-by-step learning as well as an adaptation process. More specifically, the implementation of the ERM requires a mutual adaptation between the organizational context and the enterprise risk management system so that the design of the architecture model and that of risk management are seamlessly link to facilitate a full integration of the implementation.

By combining the two theoretical perspectives previously described, it appears that implementing ERM demand an adaptation of the social aspect and

technological aspect of the organization and the ERM at all dimensions.

VI. HYPOTHESES, CONSTRUCTS AND RESEARCH MODEL

Regarding the technical system, given the systemic nature of ERM, we favor the dynamic capabilities of the company. These make a reference to the capability of the company to sense, grasp, and adjust to generate and exploit the internal and external skills that are specific to it (Bogers, Chesbrough, Heaton, & Teece, 2019; Petricevic & Teece, 2019). The essential premise of this approach is that it is still necessary for managers and entrepreneurs to corporate, develop, and reconfigure the in and out abilities to constitute the changing environments of the organization. In essence, this approach involves understanding technological change as much as organizational change.

6.1 Capacity of integration knowledge

ERM consists of integrated ERM. It is, therefore, a system where goes through different functions of the organization such as marketing, production, finance, etc. However, each function of the organization constitutes a center of excellence bringing together specialists in a particular field under one roof. As such, each function constitutes a specific area of knowledge with its way of reasoning, its methods, its tools, and its vocabulary. Consequently, the interfaces between the functions constitute frontiers of knowledge. The characteristics of knowledge that lead to innovative solutions to problems within a function can, in reality, hamper problem-solving and the creation of knowledge between functions (Carlile, 2002). These knowledge boundaries constitute a paradox insofar as most of what a company produces finds its source in these areas of specialized knowledge, which also constitute a challenge for the organization when the time comes to integrate them since the different functions are interdependent. The ERM is based on this interdependence and therefore raises the question of knowledge management at the level of these borders between the different silos of the organization. Carlile developed a management knowledge model, which we propose to apply to the problem of knowledge integration raised by the ERM (Carlile, 2002, 2004; Carlile & Rebentisch, 2003). For this, we will first briefly present this framework, then develop the arguments for its application to the implementation of ERM.

According to the previous development, we pose the 1st hypothesis:

H1: The ability to integrate knowledge between the different functions of the organization positively influences the success of the implementation of ERM.

Table 2 Capacity of Knowledge Integration

Please indicate, to what degree current information incorporation frameworks of the following types are used to implement the ERM program:	
CKI1	a common lexicon/language to describe risk
CKI2	common meaning regarding integrated risk management
CKI3	common interests among organizational functions

6.2. IT capacity

As already suggested, the introduction of the ERM means that improvements to the operational framework can be made to represent the way in which the various organizational elements, such as responsibilities, structured procedures, and evolving routines, are now related. In order to facilitate the production and execution of these changes, the company must have IT capabilities spanning technical and organizational dimensions (Bharadwaj, Sambamurthy, & Zmud, 1999). In particular, the company must have the capacity to maintain a close and continuing relationship between business and IT managers. We must also have the ability to jointly change organizational and technical processes in order to preserve their performance and effectiveness and to take advantage of the capabilities of evolving the actors. In order to have such capabilities, the company must have a relatively robust and interconnected IT infrastructure. It proves to be of paramount importance because it makes it possible to maintain continuity and "interoperability" between the various systems in place in the company (Kayworth, Chatterjee, & Sambamurthy, 2001). In addition, the variety of hardware, operating systems, and development resources increasingly necessitates the maintenance of a sufficiently cohesive IT infrastructure to avoid fragmentation and lack of integration between various systems (Lee & Chang, 2020). However, in order to maintain this consistency between risk management systems and the numerous other information systems, networks, and applications that are essential to the mission of organizations, the technical infrastructure must have the required architectures. In reality, this integrated IT infrastructure will provide a forum through which the shared IT capabilities of the company are expressed (Albertivan, Limantara, Rachmadiati, Pamungkas, & Surantha, 2019; Du, Pan, & Wu, 2020; Weill, Subramani, & Broadbent, 2002).

Finally, an organization with the capacity to keep a close interrelation among IT practitioner and IT consumer, that of making continual adjustments between its operational and technological processes to not only facilitate these changes, but also to allow operation for future technologies, meets the plausible conditions both for the implantation of innovation such as ERM and for its efficient exploitation, hence our 2nd hypothesis:

H2: The existence of an IT infrastructure positively influences the success of the ERM implementation.

Table 3 IT Infrastructures Dimension

Partnership Between user and IT's Professional	
PBT1	Multidisciplinary departments in this company help to combine business and technology skills.
PBT2	The partnership between office management and IT operators is nurtured in this organization.
PBT3	The organization's climate nurtures IT project championship
Integration of Business and Technology Processes	
IBT1	Application portfolios are consistent with business processes
IBT2	The organization's corporate work processes were reorganized to exploit opportunities.
IBT3	The organization's IT work procedures were reorganized to maximize opportunities.
Flexible IT'S Infrastructure	
INFR1	The IT infrastructure of the company allows a quick and efficient response to emerging requirements and prospects.
INFR2	If we ever need services to do tasks they were not intended to do, it is almost impossible for IT services/personnel to accommodate our requirements.
INFR3	The organization experienced difficulty each time it was necessary to integrate new systems with old ones

6.3 Capacity for organizational change

By its nature and principles, ERM is a component of organizational strategy. Therefore, the implementation of the ERM amounts in part to implementing the company's strategy. According to the traditional approach of strategic management, we agree to distinguish the formulation of the strategy from its implementation (McGuinness & Morgan, 2005). Some authors attribute the difficulties

encountered in implementing the strategy to this dichotomy (Armenakis & Harris, 2009; Barton & Ambrosini, 2013; Jeong & Shin, 2019; Rozanna, Adam, & Majid, 2019). An alternative to this traditional approach is to adopt a dynamic strategy perspective that considers implementation to a wider range, the larger organizational change environment. In fact, change management is on the managers' priority list when it comes to implementing ERM. Indeed, the establishment of the ERM supposes that the organization modifies its traditional way of conducting its business and, in particular, to modify the work processes. The characteristic and range of these changes require that the company has a specific dynamic capacity, namely: that of effectively implementing continuous change since the effectiveness of implementing a strategy is assessed by the organization's capability to implement continuous change. Capacity for organizational change is characterized as a relatively broad dynamic capacity of the organization that helps it to adapt its old capacity to face new challenges, to capture new opportunities as well as to generate new capacity (Judge & Elenkov, 2005). In 2011, Soparnot defined the capacity for organizational change as follows:

Based on the above, we pose the 3rd hypothesis:

H3: The ability to change the organization positively influences the success of the implementation of ERM

Table 4 Organizational Change Capacity

Do business unit leaders:	
OCC1	To articulate a reliably positive view of the upcoming years?
OCC2	Will they show confidence in endorsing proposals for change?
Do intermediates in this company:	
OCC3	Do top executives interact effectively with frontline employees?
OCC4	Balance programs while the job is done?
Do your change leaders:	
OCC5	Demand that the remainder of the business unit is respected?
OCC6	Willing and in a position to question the status quo?
Do we have a philosophy of organization that:	
OCC7	Promote innovation and changing values?
OCC8	Does it have the opportunity to entertain new ideas?

Do frontline staff::	
OCC9	have chances to voice your warning about change?
OCC10	Overall, do senior management regard them as credible?
Will change champions accept the:	
OCC11	Implications of transition on interdependent systems?
OCC12	Need opportunities to realign with needed adjustments?
Do the staff all over the company unit:	
OCC13	Comply with the deadlines and uphold obligations on resources?
OCC14	feel responsible for getting the job done?
OCC15	Have straightforward instructions on who's got to do what?
Does knowledge actually flow?	
OCC16	From Supervisors to Employees?
OCC17	In an opportune manner?
OCC18	In all divisions of the organization?

6.4 Graduate student intern

When one runs an SME, it is extremely difficult to mobilize all the skills and resources necessary for the proper functioning of the company internally, especially at start-up. Only one solution is then offered: outsourcing, also known as subcontracting.

Delegating part of the work to a third-party partner structure can involve a certain number of risks for the company, but it can also bring many advantages. Let's go back in detail to what it really means to subcontract in the context of managing an SME. Subcontracting is the fact for a company to delegate to another company or a person, the realization of part of its production or sales. In the event of a surge in operations, for example, or as part of a company plan from the outset, subcontracting may be performed on an occasional basis.

The fact of subcontracting differs from a simple contract with suppliers in the sense that the ordering company retains responsibility for the service or product offered to the end client. Subcontracting to a third party can involve several types of risk.

Regarding quality, we must ensure that the work with partners will guarantee the quality standards expected by the customers, with whom we remain responsible no

matter what. So, for example, provide for late penalty clauses, which will allow you to define your collaboration.

Rather, make trusted partners work, recognized, and before entrusting a large project to an unknown subcontractor, test it beforehand on less engaging missions.

Financial risk also engages us vis-à-vis our partner. In case of disagreement or unpaid by the end customer, you will still have to respect your own commitments to our partner and assume to have to pay the service without having been paid ourselves.

Outsourcing can also have many advantages. First, it allows us to free ourselves from certain constraints and entrust them to one or more external service providers. Therefore We will, have more flexibility. SMEs, could also help break out of their isolation by developing new business opportunities. In fact, by collaborating with companies or a person that is part of our close ecosystem, we multiply the chances of opening ourselves up to new business sectors or new markets. Subcontracting can also allow us to structure a powerful network and thus place a company as a hub with the capacity to put in contact with many companies mastering transverse skills.

Finally, do not forget that for some SMEs, subcontracting is not an option and is an integral part of their mode of operation. It is estimated today that between 30 and 50% of SMEs subcontract, depending on the sector.

This strategy is, hence extremely widespread and contributes to the advancement of many small businesses. It is an essential growth vector that can also allow one to focus on a commercial approach, for example, and to free oneself from production monitoring constraints that are sometimes heavy and restrictive when starting a business.

Overall, the best solution is to establish a real relationship of trust with the companies to which we subcontract. We must be able to trust each other over the long term if one is to minimize the risk of disagreements and dysfunctions.

The outsourcing problem for SMEs, especially in developing countries, is the financial sector, where most do not have the means for outsourcing.

From the above statement, we can propose the 4th hypothesis:

H4: outsourcing a university student (post-graduate management student) influences the success of ERM implantation positively.

Table 5 Outsourcing university student

UNI1	The presence of university student intern will create a significant competitive environment among workers
UNI2	Student at university has the ability to offer major market benefits to the firm
UNI3	A university student is a secure consultant
UNI4	University students will be dedicated to secure an experience or a future job at the firm

In conclusion, we assume that the elements of the technical systems contribute, as illustrated in Figure 1, to the successful implementation of the ERM.

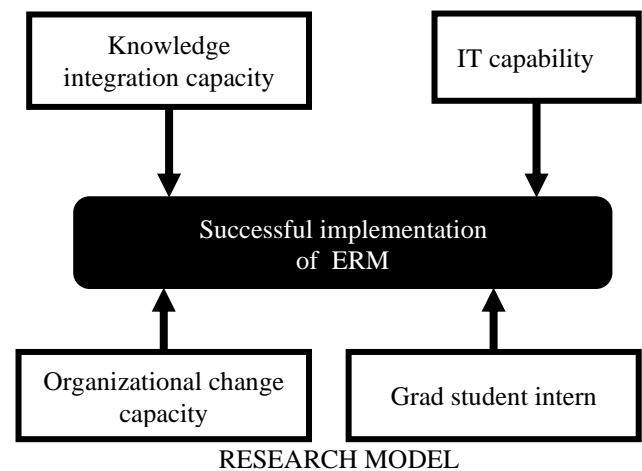


Fig.1: Proposed research structure model

VII. EXPLORATORY FACTORIAL ANALYSIS (EFA)

Our work is in essence exploratory, and our goal is to test its hypotheses. The provisional explanation that we offer is made through the structural model. We borrowed the majority of our instrument constructs developed in other contexts and objects of study. All of this raises the need to check whether, in fact, the indicators belong to the constructs they are supposed to define. In fact, this amounts to clarifying the factor structure underlying the data and, possibly, to reducing it in the event that indicators are weakly correlated with their constructs.

We have conducted four iterations of exploratory factor analysis using a Varimax rotation in principal components to explain the factor structure behind this database.

The aim of the AFE with *Varimax* rotation is to:

- (1) check that each item is correlated to a single factor with a significant factorial factor (loading),
- (2) check that this factor is the same for all the items which are supposed to return at the same latent construct, and
- (3) finally, identify the appropriate set of factors that summarize the maximum data variability.

Table 6 Fourth round of the Exploratory Factor Analysis

Construct	item	loading
Know. Interg.	CKI1	0.771
	CKI2	0.837
	CKI3	0.753
	IBT3	0.810
	INFR1	0.808
	INFR2	0.789
	INFR3	0.731
	OCC1	0.754
	OCC5	0.862
Organ. Change	OCC6	0.883
	OCC9	0.760

Grad. intern	OCC10	0.790
	OCC11	0.779
	OCC14	0.862
	OCC15	0.807
	OCC16	0.719
	OCC17	0.741
	OCC18	0.775
	UNI1	0.843
	UNI2	0.821

VIII. THE ASSESSMENT OF STRUCTURE EQUATION ANALYSIS

We will examine the structural relations between these constructs in this section and present the results of the hypothesis study. As stated, the PLS approach to structural equations has checked the hypotheses. In order to decide whether the structural model coefficients are significant or not, a bootstrapping technique with a subsamples set N equal to 2000 and Two-Tailed test forms with a significant level of 0.1. We used a unidirectional test for all hypotheses of our model that was used (Teo, Wei, & Benbasat, 2003)

Table 7 summary of the structural model

Hypotheses Relationship	Std Beta	Std Error	[t-value]	Decision	f ²	q ²	95%CI LL	95%CI UL	P-value
IT capability--> Implementation Success	0.168	0.107	1.736	Supported	0.03580	0.01810	-0.013	0.335	0.083
Organizationalchange--> Implementation Success	0.109	0.149	0.77	Not Supported	0.01481	0.00319	-0.204	0.309	0.441
Studentintern--> Implementation Success	-0.139	0.11	1.222	Not Supported	0.01852	0.00319	-0.315	0.049	0.222
Know.integration--> Implementation Success	0.221	0.102	1.935	Supported	0.03580	0.02556	0.06	0.395	0.053

IX. SUPPORTED HYPOTHESIS TESTS

Impact of IT capacity on Implementation Success of ERM

The presumed link between “IT capability” and “Implementation Success” is statistically significant, with p equal to 0.083 less than 0.1 significance level during the bootstrapping simulation. We confirm that the greater the IT capability is, that is to say, that better technical engineering support helps the involvement in

implementing the integrated risk management, the greater probability of success of the implantation of ERM ($\beta = 0.197$), the hypothesis was supported. Specifically, when IT increases by one standard deviation (σ), the successful implementation of the ERM increases by 0.197σ .

Knowledge integration capacity on ERM implementation success

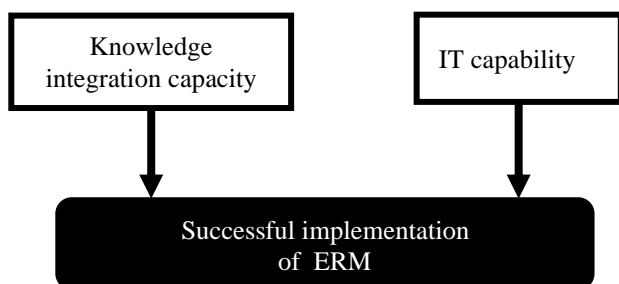
we presumed a link between “Know. integration” and “Implementation Success,” which has a p -value equal to

0.053 < 0.1 significance level. We confirm that the greater the capacity for Knowledge integration in the company, particularly the capacity to set an awareness culture, the greater the degree of success of the implementation of ERM ($\beta = 0.204$), the hypothesis was supported. Specifically, the successful implementation of the ERM increases by 0.204 σ when the capacity for organizational change increases by one standard deviation (σ).

X. CONCLUSION

The research aimed to understand the technical elements factors that could influence the the implementation of risk analysis in SMEs. There are two parts to this paper, devoted to displaying the findings of the research. The analyze by exploratory factor analysis method through SPSS (EFA) and the Structure Equation Model (SEM) via Smartpls to measure the model, assess the structure of the model, and test our hypothesis. We then present the results of the structural equations through the approach of the least partial squares (PLS), where assess the structural model through hypothesis tests. The results shows that out of the four hypothesis only two are supported namely : IT capability and Knowledge integration capacity.

Revise model



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Post-covid theoretical Perspectives on Social factors for the Successful Implementation of ERM in Developing Countries' informal SME

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Abstract— *Our research aims to highlight the critical factors for the success of the implementation of Risk Management in the informal SME organization. To this end, we establish a model, that is to say, a kind of reference framework capable of improving our knowledge of the determinants of successful implementation of ERM (enterprise risk management), on the one hand, and of guiding the companies involved in this establishment, on the other hand. Given the nature of ERM, we first study its current situation among the developing countries' informal SME (small and medium enterprise) to determine the critical difficulty of its implementation and reflect on the next stage of the research. The results lead us to adopt a systems approach; that allowed us to: conceptualize the issues associated with the establishment of the ERM as a whole in the sense of identifying the elements and their attributes; to determine the relationships between these elements, and consider the complexities of integrated risk management promoted by ERM through the social aspect of the organization. As a general theoretical framework, we used socio-technical theory, which oriented our thinking towards constructs like strategic framework, employee involvement, support from management, structural arrangement and organizational climate, on the social side; Our research approach is exploratory with a correlational study design and survey research. We reduced the data using exploratory factor analysis. For the proper statistical modeling, we used structural equations by the partial least squares method. For this, we used the SmartPLS software and SPSS. The results are satisfactory and have allowed us to detect problems in the operationalization of certain constructs, validate some of the hypotheses, and to draw conclusions, which we have broken down at the beginning. These results also showed us that other factors could be considered, and others that are not necessary to consider in such a student intern.*

I. INTRODUCTION

Enterprise Risk Management (ERM) designates a comprehensive risk management approach, which proposes that all the risks involved in a company's value creation process be systematically considered.

To resolve the problems inherent in traditional risk management methodologies in which each department operates in a silo by adopting its methods and techniques, researchers and management practitioners have set themselves the task of developing a process that considers all the risks systemically that the organization faces given

the strategic and operational choices it makes. The objectives are basically to allow management to understand what it takes to manage risks throughout the daily activities of the organization, to provide a company-wide perspective according to the risk profile of the company and the mechanisms control by aggregating and integrating a set of key information and, ultimately, proactively identifying and assessing all significant categories of risk, not forgetting how they affect business objectives of the organization. The proponents of ERM hope that, in the long term, achieving these fundamental objectives will not only allow the company to create value by reducing income volatility, but also to comply with the requirements of certain regulations. As a result, many companies have adopted ERM. However, success stories of ERM implementation are quite rare. Few companies have managed to derive the benefits associated with ERM not because of the methodology itself, but rather because of its performance. Indeed, there are currently no studies presenting an approach favoring the establishment of ERM, especially in Comoros. During our residency, the managers' questions consisted mainly of knowing the factors to ensure ERM implementation is successful.

The research concerns associated with such an enterprise might seem to belong to financial management; however, it is important to transpose them to the large scale of organizational management and hence risk management, given the holistic or overall ERM. This transposition brings the problem back to the assessment of ERM implementation success factors.

In the literature in financial management as well as in management, the question of the establishment of ERM is completely forgotten. Existing studies focus on the content of the ERM, its benefits, and the proposal of different frameworks. The fact that experts and practitioners agree on the need to implement ERM as a new approach for risk management illustrates the importance of the issue, indicating that it must be effectively implemented within the organization in order to reap the full benefits of ERM. On the basis of the above, our research project consists of determining the success factors for implementing ERM.

II. THEORETICAL SOCIAL PERSPECTIVE

ERM is increasingly adopted by organizations to deal with the variety of risks faced by organizations today. The adoption of ERM, however, raises more questions than current research can answer. Due to the relative novelty of ERM, research, although quite numerous, appears to be a little diversified in terms of research questions. In particular, we have been able to list only a few empirical studies relating to the implementation of ERM. However,

we understand that the successful implementation of an ERM project must be a complex and difficult enterprise if only by the changes it involves in several areas of the organization such as business processes, organization work, the collaboration between units and culture, etc. In other words, implementing the ERM requires considering a set of organizational issues linked to each other.

In addition to the difficulty related to the implementation of ERM being part of a system dynamic, ERM itself is revealed as a systemic practice. Unlike traditional risk management approaches that operate in isolation, enterprise risk management advocates an integrated system that assimilates risk management across the enterprise. In other words, risk management processes integrate the multiple functions of the organization. As the risks are considered to be interrelated, each measure to mitigate a specific risk is subject to an assessment of its impact on the other risks. In essence, ERM is a systemic approach to managing organizational risk.

Given the holistic nature of ERM, the system approach seems the most appropriate. This approach makes it possible to conceptualize the challenges associated with the implementation of the ERM as a whole in the sense of identifying the elements and their attributes, determining the relationships between the elements, and finally, taking into account the dynamics of management of the risks recommended by the ERM. More specifically, we understand ERM as a social system.

III. HYPOTHESES, CONSTRUCTS AND RESEARCH MODEL

We reflect on the different mutual adaptations between the organizational context and the ERM as socio-technical systems. From these reflections, hypotheses are formulated, then articulated to form a research model that has been tested during the empirical phase of this research. We emphasize that the operational definition of each construct is given in the next chapter dedicated to the methodological framework.

3.1 Strategic steering framework

The second element of the steering framework is the business rationale for the ERM project. This rationale summarizes the value propositions, which help to justify the deployment of the organization's resources to the implementation of the project. On this account, the business rationale offers an alternative approach to how the project could be justified, finance, legalize, and monetize. In particular, for ERM-type innovations, which combine the properties of administrative and technical innovations, a well-developed business rationale not only

serves to signal the importance of applying an explicit justification logic, but also identifies a variety of criteria used to justify the project (Uzarski & Broome, 2019). Such rationality is developed and passed on by chief management as a way to inform and communicate to the rest of the management officer the correct and appropriate way to implement ERM within the business procedures of the organization. The literature on organizational innovations and the literature on information technology is replete with studies that have argued that business rationale is likely to help assimilate innovations. As seen by Hardy and Dougherty, companies that value innovation activities tend to be successful in dealing effectively with the innovation procedure (Dougherty & Hardy, 1996). In 1986, Van de Ven emphasized the benefit of such a creation of critical value in creating a cultural organization that endorses and promotes innovative efforts (Van de Ven, 1986). Note that this rationale must highlight the expected benefits of the project as well as the changes necessary for this purpose. Despite the strategic nature of the business rationale, it must be broken down to the most operational level in order to be understood by those responsible for implementing project activities (Supriyono & Sutiah, 2020). In this sense, the business rationale can help convince the members of the company of the need for the project, and therefore, get their involvement.

From this perspective, our first hypothesis is:

H1a: The strategic steering framework positively influences the involvement of members of the organization towards the ERM project.

Table 1 Strategic steering framework

Vision	
V1	Management helps us understand where the project is headed
V2	We understand the project definition, objectives, and strategy
V3	Guidelines from management allow us to understand how to adjust our own work so that it is consistent with the project objectives
Business Rationale: Please indicate the extent of importance placed on the following in justifying ERM related expenses in your organization	
RA1	Meeting return on investment
RA2	Expected business value to be achieved
RA3	Realizing cost savings

3.2 Involvement of stakeholders/employee

The concept of employee involvement as an action-oriented process of job satisfaction is presented and illustrated by many different researchers. However, the work of Lawler remains the one that has had the most posterity in the sense that it forms the basis of the majority of the work to date (E. E. Lawler, 1969; E. E. Lawler & Hackman, 1969; E. L. Lawler & Moore, 1969). Lawler defines employee engagement as being driven by the following four processes: power, information, knowledge, and rewards. In detail, he suggests that, to get involved, employees need to receive relevant information and performance feedback; the job must give them a chance to use their ability, mastery, and understanding; they should feel that they have some control and power in setting goals (Wohlgemuth, Wenzel, Berger, & Eisend, 2019; Yu & Liu, 2020). The conceptual foundations of Lawler's work come from that of Hackman and Oldham, who themselves developed their model from the early work of Herzberg (Hackman & Oldham, 1980; Herzberg, 1966; Lawler III, 1986). Lawler argues that the previous four processes must be integrated into the organization in parallel. If not, efforts to involve employees will fail and result in frustrations, poor decisions, lack of motivation, and inefficiency. Conversely, Bowen and Lawler have argued that integrating these four processes results in the sense of belonging on the part of employees (Bowen & Lawler III, 1995). Recently, Judeh found a positive correlation between the involvement of employees and the performance of teams (Judeh, 2011). However, it is clear that, in the case of the establishment of the ERM, it will be necessary to set up teams of various natures. Taking all of this into account, our second hypothesis is:

H1b: The involvement of the employee (ERM) of the organization has a good impact on the successful implementation of the ERM.

Table 2 The involvement of the employee

Power	
Power 1	To Encourage action to be taken before asking for consent.
Power 2	To Encourage research around the boundaries of organization and function.
Information	
Info1	Enough information to do my task in the project
Info2	Enterprise leadership offers a clear view of company strategy
Knowledge	

Know 1	Given real opportunity to improve Risk Management skills
Know 2	Ability to obtain developmental experiences to apply the ERM approach
Know 3	Coaching and feedback about performance is received
Reward	
Reward1	Feel appreciated by management
Reward2	Satisfied with praise for a job well done
Compensation	
Comp 1	Have skills and abilities to get the job done
Comp 2	Effectively team and work with other groups

3.3. Senior management sponsorship/oversights

The strategic framework is necessary to motivate the players in the company to get involved in the ERM implementation project. However, experience has shown that this influence can be mitigated in the absence of top management, which we define as management's beliefs in ERM initiatives and their participation in them. Management sponsorship defines the firm standards and values, which dictate the way the manager has to reflect during the design of ERM activities. Through its beliefs, management offers a vision and directives to heads of departments or units regarding the business opportunities and threats related to ERM and its implementation (Chatterjee, Grewal, & Sambamurthy, 2002). The fact that leaders believe that the ERM offers a strategic opportunity sends a strong signal to the management community about the importance they attach to the ERM implementation project. Better still, by referring to the precepts of institutional theory, we can anticipate that, by their beliefs and participation in ERM initiatives, leaders allow the will of managers to explore different ways in which ERM can be integrated into corporate business processes (Lin, McKenna, Ho, & Shen, 2019). It can also lead them to agree to provide the resources and exercise the authority and control necessary for a project's success (Slevin & Pinto, 1987). In short, the beliefs of leaders, supported by their participation, not only help to give meaning to the innovation project, but also to legitimize it in the eyes of the members of the organization. Therefore, we propose a third hypothesis:

H2: The sponsorship of senior management has an advantageous effect on the success of establishing the ERM.

Table 3 Support from Management

Please state to what degree your company's senior management believes in the following:	
B1	ERM has the capacity to generate major business advantages for the company.
B2	ERM is setting up a significant competitive arena for the company.
B3	ERM is a risk management secure methodology to conduct business activities
Please state to what degree your company's senior management regularly participates in:	
Part 1	To Set up a vision for ERM's organizational use.
Part 2	To Formulate an operational plan for the use of ERM.
Part 3	To Set up goals and norms to monitor risk management via ERM.

3.4. Structural adaptation

According to the theory of interaction from which the perspective of mutual adaptation derives, information, technology, people, and structure form a kind of socio-technical network (Mason, McKenney, & Copeland, 1997). Much research shows the advantage of adapting operational structures to accommodate the implementation of an innovation (P. G. Klein, Mahoney, McGahan, & Pitelis, 2019; Petricevic & Teece, 2019; Treku & Wiredu, 2018). A critical aspect of the interaction between innovation and the social aspect in which it is implemented lies in the fact that several managers influence this implementation and are probably to have different explanations concerning the usefulness and the importance of the innovation. It is, therefore up to the organization to build consensus on the project. Collaboration theory assumes that decisions and acts of managers can be related by the use of a number of mechanisms of collaboration, including routine processes, liaison positions, and supervisory teams. Each of these mechanisms has specific advantages. For this, organizations frequently combine traditional and modern, theoretical, and practical processes of the integration process to manage their operations. Coordination mechanisms are indeed vital for sharing and integrating the knowledge distributed across the firm. In the particular context of the implementation of the ERM, coordination is essential to integrate the specific

knowledge developed and accumulated in the various functional departments and the role of the company.

H3: The use of coordination mechanisms has a positive impact on the successful implementation of ERM.

Table 4 Structural Arrangements

Please indicate, to what degree current communication structures of the following types are used to coordinate the ERM initiative:	
SA1	Standard Operating procedures (e.g., goals, policies, and plans)
SA2	Liaison roles (e.g., work team manager)
SA3	Task Forces
SA4	Oversight Teams (e.g., Business Advisory Council)
SA5	Planning Processes

3.5 Organizational climate

The implementation of ERM can represent a substantial change in the way a firm conducts its business, with an impact on operational management as well as on strategic management (Kimbrough & Compton, 2009). The implementation of any kind of change has always been linked to the culture of the organization (Kanter, 1984). Indeed, some of the fundamental postulates of the ERM seem particularly subject to the influences of cultural norms. It appears that it is the working surrounding, especially the culture of the organization, which hold back or encourage the establishment of ERM. In the literature, there is a certain conceptual blurring between organizational culture and organizational climate (Falcione & Kaplan, 1984; Schein, 2010). For instance, the ideologies that are a core element of the organizational climate derive from the value systems that, themselves, constitute the central element of organizational culture. This explains why Schein considers the organizational climate to be the surface component or a manifestation of organizational culture. Organizational climate is characterized as person understandings of the most meaningful features of the organizational context (Schneider, 1990). Therefore, apart from the psychosocial climate, it corresponds to trends of value shared by the employee members of the organization in relation to some aspects of the organizational scope. The interaction among measurable objective factors in the organizational system and perceptive processes of the individual organization's members will lead to this result (Wagstaff, Flores, Cannella, Sarkar, & Choirat, 2020). It follows the principle to control the meaning of

the environment by properly forming organizational context factors and mechanisms (Nikolova, Van Ruysseveldt, Van Dam, & De Witte, 2016). The conceptualization of the organizational environment globally could prove insignificant to research a given phenomenon. The concept of organizational climate should ideally be treated as a large, multilayered perceptive field with a variable of interest in the interpretation of constructs. In addition, there can be many climates in an organization setting depending on which individuals assign special significance to different sets of organizational variables or activities. Out of this standpoint, a service climate, a climate of safety in work, or a climate of self-fulfillment will describe the working atmosphere (Dwertmann & van Dijk, 2020). Only the climate factor, which appears to be the most significant to the development and practice of ERM, is taken into consideration.

H4: An organizational climate geared towards learning, integrating, and updating the know-how has a high probability of positively impacting the success of implementing ERM.

Table 5 Organizational Learning Climate

Time	
TI1	There isn't enough time in some aspects of the job to adapt to the changes.
TI2	There's no room for the things that I need to learn how to do.
TI3	I don't have the ability to learn new things.
Team	
Team1	If we ask for support from each other, it is granted.
Team2	There's someone willing to answer if I have a question about my work.
Team3	We acknowledge one another's shortcomings and weaknesses.
Team4	Ones with important information are eager to share it with others.
Team5	Almost everyone shares work-related information.
Development Opportunity	
DO1	There are several different ways of discovering new work here.
DO2	I have resources beyond my daily work to find out about performance issues.
DO3	If one decides to try something different, they

	have the opportunity to do it.
Guidance	
GUI1	There are written instructions on how to do my job for someone like me to turn to.
GUI2	There is no guidance or informal instruction.
GUI3	I obtain knowledge related to my work.
GUI4	My education gives an overview that I need to know and understand.

Table 6 Organizational Climate Integration

Integration	
INT1	Various company divisions keep each other updated on what is happening.
INT2	My team/workgroup in this company is in cooperation with other staff or divisions.
INT3	We are frustrated by other teams and divisions in our attempts to boost ERM.
INT4	The company acknowledges and promotes collaboration among staff and divisions.

3.6 Successful implementation of ERM

The construct of the successful implementation is essentially related to the efficiency of the implementation of a new method or idea. As such, it relates to the continuity and efficiency of the use of development by the targeted members of the company (K. J. Klein & Sorra, 1996). These refer to individuals who are expected to directly use or support the innovation, such as information technology specialists or supervisors.

Considering Laudon and Laudon, we have retained the following indicators as the constitutive elements of the construct "Successful establishment of ERM," which are presented in Table 4-11 (Laudon, 2007).

Table 7 Successful Implementation of ERM

Does the successful implementation let you realize:	
SIE1	High level of program use.
SIE2	User satisfaction with the program.
SIE3	A positive mindset in terms of program features.
SIE4	Program goals were achieved.
SIE5	Economic rebound.

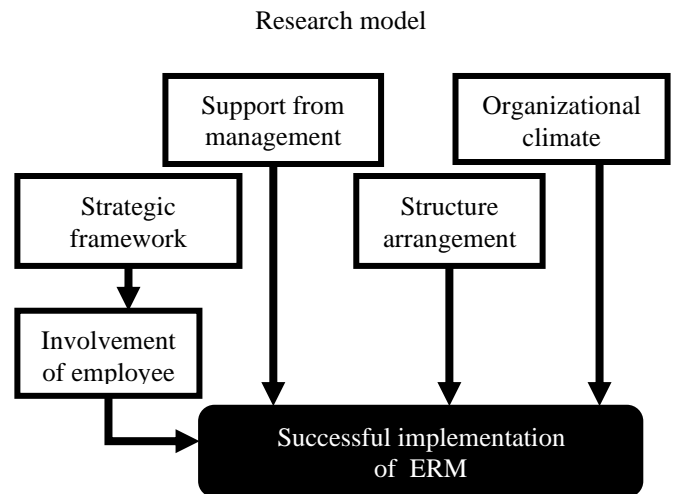


Fig.1 Proposed research structure model

IV. STATISTICAL DATA ANALYSIS

On the strength of this, we opt for a statistical analysis procedure using both exploratory analysis and structural equations.

4.1 Exploratory factor analysis (four round)

Before proceeding to the analysis by structural equations, we carried out a purification of the data by means of an EFA in order to highlight the latent structures. Indeed, the variables defined in our conceptual framework are theoretical constructs that are not directly measurable and whose existence is postulated using abstract reasoning specific to the fields of applications from which we borrowed them. The essential objective of exploratory factor analysis (EFA) is, in accordance with its theoretical aims, to identify latent structures. We only keep the variable with 0.7 load or above.

Table 8 Selected measurement model

Construct	item	loading
Implementation Success	SIE4	0.864
	SIE5	0.847
Strategic steering framework	V1	0.789
	V2	0.816
	V3	0.810
	RA3	0.733
Employee Involvement	Power1	0.739
	Info1	0.745
	Know1	0.777
	Know2	0.791
	Know3	0.732

	Reward1	0.764
Support from Management	B1	0.867
	B2	0.741
	B3	0.872
	Part1	0.802
	Part3	0.758
Structural Arrg.	SA1	0.829
	SA2	0.898
Organ. Climate	TI1	0.771
	TI3	0.893
	Team4	0.749
	DO1	0.838
	DO3	0.840
	GUI1	0.854
	GUI3	0.805
	INT1	0.854
	INT3	0.757
	INT4	0.798

4.2 The Structural Equation Analysis in SmartPLS

After having purified the data via exploratory factor analysis, we undertook the two stages of the analytical procedure recommended by Anderson and Gerbing, namely the measurement model assessment proceeded by the structural model (Anderson & Gerbing, 1982). In both cases, we used SmartPLS software. Our research model now includes 10 constructs, 9 of which are reflexive and one formative. The PLS strategy to structural equations has proven to be the most appropriate due to the fact that it allows both reflexive and formative constructs to be treated, unlike the maximum likelihood approach used in software like LISREL or AMOS. Furthermore, PLS is less restrictive with regard to the sample size, scaling, and residue distribution (Chin, 1998; Chin, Marcolin, & Newsted, 2003; Chin & Newsted, 1999). In what follows, we present the results relating to the summary of the structural model.

Table 9 Summary of the structural model

Hypotheses Relationship	Std Beta	Std Error	[t-value]	Decision	f ²	q ²	95%CI LL	95%CI UL	P-value
OrganizationalClimate--> Implementation Success	0.163	0.159	0.943	Not Supported	0.02593	0.00852	-0.261	0.361	0.346
Stra.framwork--> Involvement of employee	0.22	0.092	1.941	Supported	NA	NA	0.109	0.347	0.052
Structurat.Arrg--> Implementation Success	0.002	0.101	0.037	Not Supported	0.00000	-	-0.165	0.163	0.97
SuppManagement--> Implementation Success	0.108	0.125	0.641	Not Supported	0.00741	-	-0.18	0.28	0.522
Involvement of employee--> Implementation Success	0.083	0.094	0.889	Not Supported	0.00741	-	-0.064	0.251	0.374

V. CONCLUSION

In conclusion, it appears that our research has produced very interesting results. It made it possible to confirm or invalidate certain hypotheses that we have put forward. In particular, it made it possible to confirm that, in terms of the social subsystem, the strategic framework plays an essential part in the successful establishment of the ERM in the informal sector of SME. It also highlighted the

problem of formulation of constructs: Involvement of employee, Structural arrangement, organizational climate and support from management. As a result, their influence on the success of the implementation of the ERM is still hypothetical. From a statistical point of view, these factors showed an insignificant influence. However, the theoretical reasoning underlying the choice of these factors suggests their validity provided that their operational

definition is adapted to consider a real situation in which ERM is implemented. The same must apply to constructs that did not stand up to the test of exploratory factor analysis. In addition to formulating and testing hypotheses with all the statistical sophistication that this entailed, this study has other merits. In particular, it has that of proposing a managerial paradigm to better understand the ins and outs of the establishment of the ERM in SME in the informal sector, which until now, has been approached without much success according to the literature.

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Evaluation of the occupational safety management system: literature review

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Keywords— Integrated Risks Management, Informal Small & Medium Enterprise, Risk Implementation, Risk Management, Smartpls.

Abstract— Safety at work is a widely disseminated subject throughout the world, at various stages, regardless of the size of the organization because it is related to social responsibility and the well-being of employees and their families. The objective of the article is to carry out a literature review on the Workplace Safety System applied in the construction industry according to the Regulatory Norms. The methodology used was a systematic review of the literature in indexed databases: US National Library of Medicine National Institutes of Health Medical Literature Analysis and Retrieval System Online, Latin American and Caribbean Literature in Health Sciences and Scientific Eletronic Library Online and a Review of Regulatory Standards. It is noticed that it is possible to work in companies to identify and eliminate risks while protecting employees, since it is a legal requirement, considering the work safety management system as a strategy for increasing productivity and reducing costs. Occupational accident rates, absence and absenteeism rates. It is concluded that, the article shows that investing in health and safety management systems, reduce various types of costs and negative impacts generated by accidents, affecting not only the organization, but also the social life of employees and the environment, increasing productivity and the quality and efficiency of services. The manager needs to understand the dangers and risks and, together with the safety technician, mitigate them.

I. INTRODUCTION

Safety at work is a widely disseminated subject One of the factors that increases the level of employee awareness is investing in safety. Conducting training in the field of work safety improves the relationship between the team and it is worth mentioning that the fact that an accident never occurred does not mean that it will never happen. The entire company, be it from any branch, must be involved in job security. The campaign on work safety should be aimed at all employees, management, administration and training should be used to standardize procedures, correct deviations and thereby prevent accidents at work [1].

throughout the world, at various stages, regardless of the size of the organization, as it is related to social

responsibility and the well-being of employees and their families [2].

According to Miguel [3], in several workplaces the prevention of occupational risks is necessary, as well as the realization of risk maps with their own characteristics that contemplate an interrelation with the health security of employees regarding direct contact with biological, chemical, physical and ergonomic agents.

The statistics of the International Labor Organization (ILO) [4] places Brazil in 4th place in the ranking of work accidents in the world, with an average of 700 thousand records of work accidents per year, according to data from the Ministry of Labor. It has been known for a long time that civil construction is an activity that involves direct labor,

who use machines and equipment, are exposed to great risks, and can affect the physical integrity and health of workers.

However, if there is a Work Safety System in the companies, with programs, equipment and specifications that must be adopted to guarantee the physical and mental integrity of these works, the risks can be minimized. According to Silva [2], the civil construction sector is an activity that presents several risks, this since prehistory when men used energy sources and natural resources to cut down trees that they used to build bridges.

The research question that guided the development of this work was: what practices can be adopted to improve the characteristics of the work environment and minimize the risks and the occurrence of occupational accidents and diseases.

According to the International Labor Organization, the main causes of accidents are the deterioration of working conditions caused by globalization and the liberalization of markets, the disregard for workers' safety rights and the lack of compliance with the law or adequate safety regulations (ILO) [4].

Studies have shown that in more than 96% of accidents, risky behavior is the main cause. Risk behavior can be modified by identifying the causes and then correcting them. It is also necessary to pay attention to the quality, costs and values, and productivity that are achieved through these behavioral changes.

It is worth mentioning that a safe environment is one that supports individuals to work safely. These positive results in safety are obtained through actions and strategies applied in safety management in search of changing employees' behavioral habits. Safety in the workplace is important for the company's productivity and social responsibility.

Thus, it is essential for employees of the Personal Protective Equipment - PPE, device or product to protect against risks capable of threatening their safety and health. The use of this type of equipment can only be carried out when it is not possible to take measures to eliminate the risks of the environment in which the activity is developed.

The main authors searched in the literature were Chiavenato [5], Tavares [6], Reason and Hobbs [7], Cabeças e Paiva [8], Chu [1], Trivelato [9], Camisassa [10], Santos e Silva [11], Cicco [12], ILO [4] among others. The objective of the work is to carry out a literature review on the Workplace Safety System applied to the civil construction sector according to the Regulatory Norms.

II. METHODS

This is a systematic review of the literature in indexed databases: US National Library of Medicine National Institutes of Health (PubMed), Medical Literature Analysis and Retrieval System Online (MEDLINE), Latin American and Caribbean Literature in Health Sciences (LILACS) and Scientific Electronic Library Online (SciELO) and CAPS and a Review of Regulatory Standards (NRS). The survey was conducted in the months of March and April 2021. For this survey, the controlled descriptors of the Virtual Health Library were used, consisting of "Occupational health", "Accidents", "Biosafety", "Safety Management" and Risks obtained in consultation with Health Sciences Descriptors (DECS). The terms were used in the Portuguese language.

This review-included dissertations, theses, bibliographic reviews and case reports. As criteria for the selection, the articles were considered complete and available, in English and Portuguese, Control study, meta-analysis, and double blind. The period between 2015 and 2020 was delimited as a period.

As inclusion criteria, articles with full available text were selected, which addressed "Occupational health", "Accidents", "Biosafety", "Safety Management" and "Risks". Duplicate articles, those that did not contain the words "Biosafety", "Safety Management" and Risks and whose outcomes did not address Occupational Safety, were excluded.

The studies were evaluated based on the title and summary by the authors, and after applying the inclusion and exclusion criteria, it was possible to select 15 articles to compose the sample. The articles were analyzed according to the relevance of the topic, the validity and precision of the results. After analysis, the studies were organized in a synoptic panel according to title, year of publication, objective, methods and results) in accordance with the NRS and in a descriptive order, their data were analyzed both qualitatively and quantitatively, where, from the data collection, they were grouped and analyzed from graphs and tables, generated by the Excel 2016 program, from the Microsoft Office package. Finally, articles of similar content are grouped.

III. RESULTS AND DISCUSSION

According to Chiavenato [5], the occupational safety system are technical, medical, educational and psychological standards used as accident prevention measures, with the purpose of eliminating unsafe conditions in the work environment. Also according to the author, "it is the set of activities related to preventing accidents and minimizing unsafe working conditions" [5].

Cabeças and Paiva [8], appeared with the first man, because whenever the human being performs some work, if one thinks about safety and with the passage of time the growth of the population, the need for a professional arose just to worry about the human security. Tavares [6], in the workplace safety management system in a company, the main areas are the administration and safety of work in the support and interaction of departments and employees with issues related to work safety

According to Reason and Hobbs [7], every work accident is one that occurs in the exercise of work, at the service of the company, and may cause bodily injury or functional disturbance, including death, loss or reduction of work capacity. Law requires occupational Safety and every company needs to comply with this determination in order to do so, increase the productivity and quality of its services and improve human relations in the work environment.

According to Tavares [6], it is the job safety manager's role to invest in employee safety, complying with current legislation and making the company's employees look after themselves and their service colleagues in relation to accidents, incidents and dangers, respecting especially safety laws and regulations.

Systematically, organizations with regard to Safety and Health at Work consider and seek to solidify in their activity a firm and concrete performance and above all, with quality. Therefore, they need efficient risk controls, especially of an occupational nature, in line with the policy and objectives of the Occupational Safety System - OSH.

On the other hand, Chu [1] points out that these policies cannot disregard the legal requirements of the country's development and growth aligned to population growth by the stakeholders in Safety and Health at Work. A Safety and Health at Work management system is a set of initiatives by the organization, focused on the safety and integrity of its employees and their activities in the production processes.

A Management System for Safety and Health at Work - SGSST must be managed in compliance with the policies, requirements and laws applicable to safety issues, according to the configuration of each organization.

Trivelato [9] defines actions and policies designed to prevent accidents and occupational diseases as a safety policy and program. The implementation of these policies is foreseen in the legislation of most developed and developing countries, considering the elements recommended by the legislation applicable in the company. Regarding the culture of safety and health at work, Fig. 1 demonstrates what is necessary for it to happen.

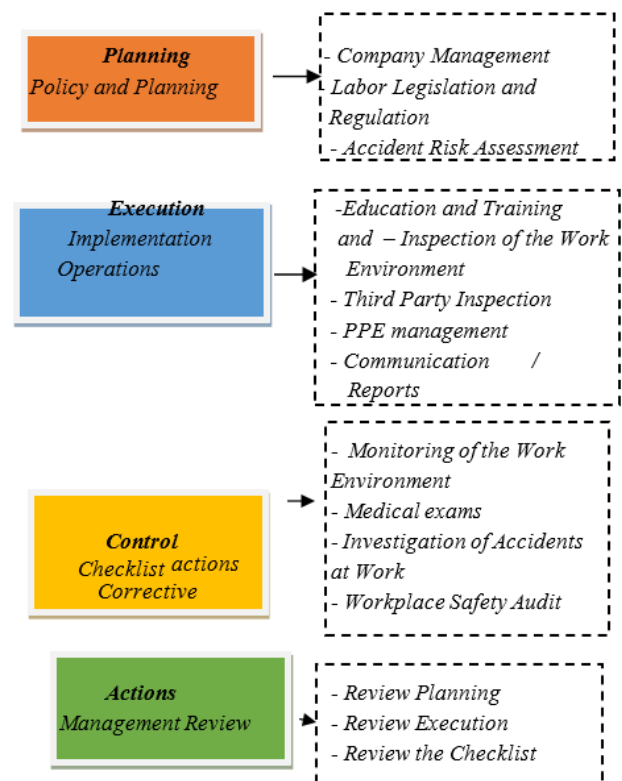


Fig. 1 - Guidelines for promoting the Culture of Safety and Health at Work

Source: adapted from Brazil [13]

Chu [1] points out that company are different from each other; therefore, the policies implemented for one organization do not necessarily meet the needs of another. It is worth remembering that the principles inherent in the management of risks to the health and safety of workers are independent of the organization of the company.

According to Camisassa [10], for the management of risks to the health and safety of employees, there are some independent and general principles for each type of company. It is worth mentioning that a systematic approach at all levels of occupational safety management is essential.

According to Santos and Silva [11], the occupational safety manager integrates into the strategic plans and management processes, documents recommended in the safety standards such as the identification of risks, analysis and evaluation of these risks, forms of control implemented; ways of reviewing programs and employee participation in improving the organization's competencies inherent in risk control.

According to the occupational health and safety policy, it is necessary to follow some principles, they are:

- Be appropriate according to the nature of its activities, the size of the company, always

assessing the protection of workers, employees, contractors and visitors;

- b) Always present the acceptance of the company's top management. This acceptance needs to be properly pointed out, documented, and made available to all employees and interested elements when applicable;
- c) Always accept the relevant legal conditions, collective agreements, applicable to its activities;
- d) Continuously guarantee the knowledge of workers or their legal representatives in OHS activities;
- e) To contemplate the commitment to OSH of all, especially the top management, of the continuous improvement in the prevention of accidents, diseases and incidents related to work, always aiming at the reduction of the situations that may cause damage to the physical and

mental integrity of the workers [13]

For Chu [1], risk management needs to be implemented at the center of the strategic management of any company, being a process where companies deal with the risks inherent in their activities. The application of management guidelines, through principles of health, hygiene and safety, accepts the identification of hazards, estimation and control of risks relevant to the process, in order to prevent the occurrence of accidents.

Cabeças, Paiva [8] emphasize that the methods of analysis and assessment of occupational risks are fundamental for the development of measures to control occupational risks. In control measures, the important thing is to be aligned with the dangers and risks so that the occurrence of these damages can be prevented. It is assumed that this alignment is effective in terms of the knowledge of the individual damages associated with the exposure of hazards and risks.

In the articles analyzed, Salamone [14], Shi et al., [15] highlight the main motivations and obstacles in the implementation of Occupational Health and Safety Management Systems (SGSST) based on the OHSAS

18001 standard, as described in the table below.

Table 1: Main motivations and obstacles in the implementation of OHSMSs

Motivations	Obstacles
<i>Image improvement</i>	<i>Very high cost</i>
<i>Lower costs</i>	<i>Lack of information</i>
<i>Continuous improvement</i>	<i>Management difficulties</i>
<i>New opportunities in the market</i>	<i>Lack of standard clarity</i>
<i>Better productivity</i>	<i>Lack of financial resources</i>
<i>Greater competitiveness</i>	<i>Lack of competent human resources</i>
<i>Pressure from customers</i>	
<i>Government pressures</i>	
<i>Product improvements</i>	
<i>Pressure from the local community</i>	

Source: adapted from Salamone [14], and Shi et al., [15]

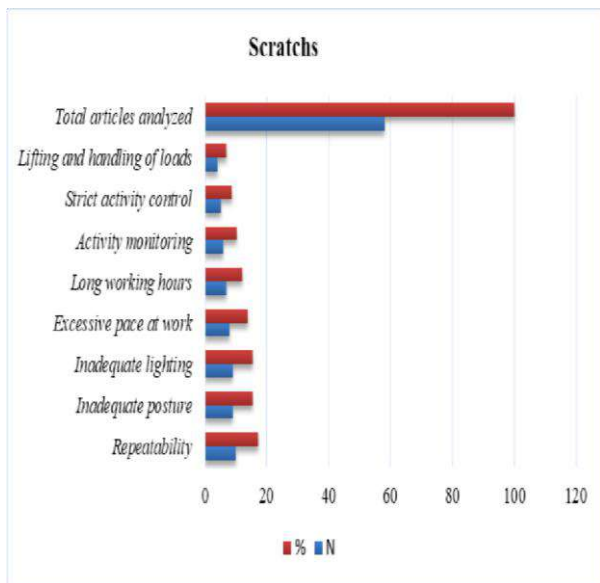
In Garrigou et al., [16] the main occupational health and safety practices were highlighted, such as: commitment of the management, they must be aware of the importance of OSH and adapt the environment to safe working conditions. Shi et al., [15] highlights occupational health and safety programs, with a risk map prepared by the Internal Commission for Accident Prevention in order to carry out a survey of the risk areas.

For Salamone [14], internal communication is one of the main occupational health and safety practices, as it defines how the organization can carry out communications through panels, banners, among other ways to inform employees. In Chu's view [1], the program for the integration of new employees, through guidance on measures to prevent accidents and occupational diseases, is one of the main safety practices.

From the point of view of Camisassa [10], preventive measures with individual prevention equipment and the involvement of the Human Resources area in training and leadership programs with the objective of improving SGSST.

In the 15 articles analyzed, the main cited ergonomic risks found in companies are:

Graph 1 - Ergonomic risks found in the analyzed articles



Source: Elaborated by the author (2021)

According to the 16 articles analyzed, repetition appeared in 10 (17.2%) of the articles, inadequate posture and inadequate lighting in 9 (15.5), excessive work pace in 8 (13.8%), Workdays prolonged in 7 (12.0%), monitoring of activities in 6 (10.3%), strict control of activities in 5 (8.7%) and lifting and handling of loads in 4 (7.0%). It is justified that in the total that appears in the graph of 58 articles despite having been analyzed 16 articles because risks appear in more than one article.

It is noticed that it is possible to work in companies to identify and eliminate risks while protecting employees, since it is a legal requirement, considering the work safety management system as a strategy for increasing productivity and reducing costs. Occupational accident rates, absence and absenteeism rates.

IV. CONCLUSIONS

Over the years, the health and safety of workers has led to regulatory standards for employees to perform their duties safely. In this way, occupational health and safety management systems seek to adjust the workplace to the employee in order to comply with current regulations, providing a sense of well-being and maintaining or improving their productivity and efficiency.

The lack of an occupational health and safety management system generates several disorders to the institution, such as taking an employee to suffer temporary or permanent injuries, which can affect the workplace in the event of an accident and thus generate losses for the company. Company, but to all interested parties, with the

loss of productivity, I damage the image of the company and financial.

The main causes of accidents pointed out in the articles are negligence, lack of training, inadequate jobs, lack of attention, but with work, management and safety due to costs and lack of incentives can be minimized if these standards were implemented in companies. With the application of SGSST, accidents can be minimized within the company, as well as the dissemination of knowledge through training.

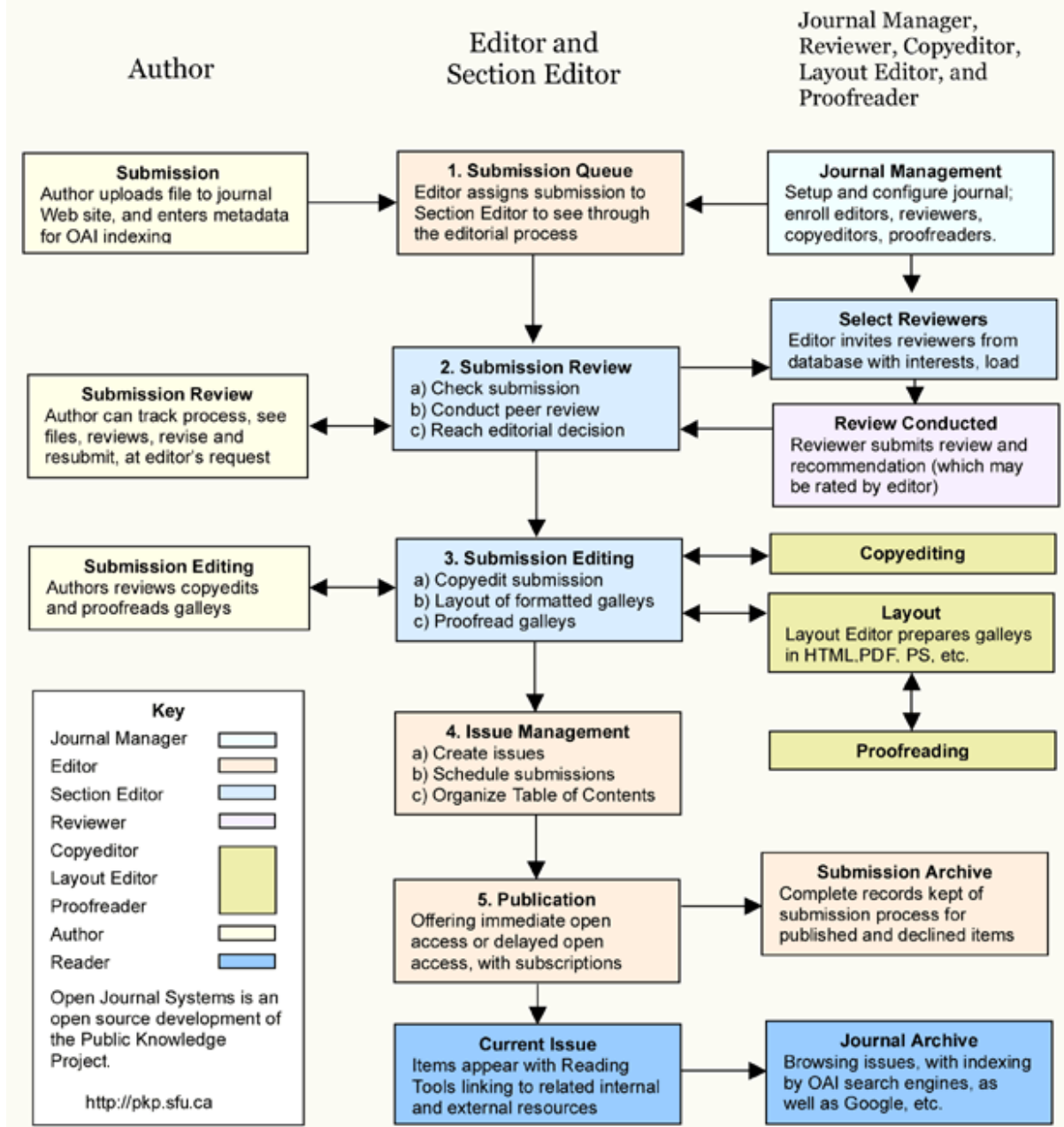
The article shows that investing in occupational health and safety management systems reduces various types of costs and negative impacts generated by accidents, affecting not only the organization, but also the social life of employees and the environment, increasing productivity and quality and efficiency of services. The manager needs to understand the dangers and risks and, together with the safety technician, mitigate them.

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